Draft Final
Remedial Design Report

Third Site ERH
Zionsville, Indiana

PREPARED BY:

McMILLAN-McGEE CORP

CREATORS OF ET-DSP™

Draft Final Remedial Design Report

Installation, Operation and Maintenance of ERH at Third Site Zionsville, Indiana

PREPARED FOR:
THIRD SITE TRUST FUND

SUBMITTED TO:
U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 5

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

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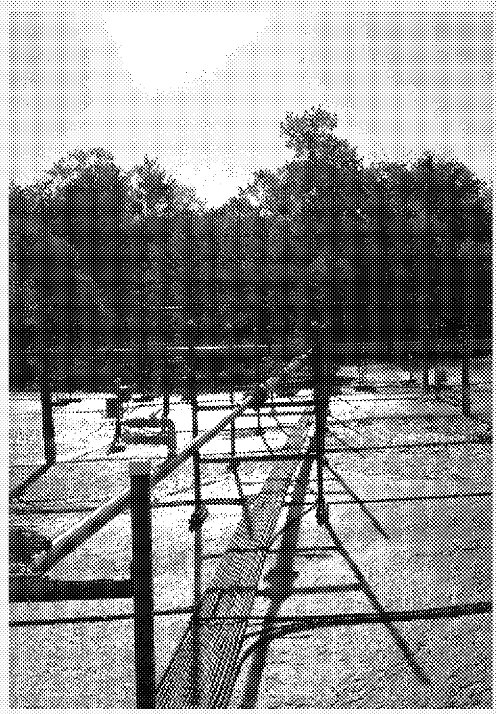

Executive Summary

McMillan-McGee Corporation (Mc^2) has prepared this remediation design report to describe the details of the Electro Thermal Dynamic Stripping Process (ET-DSP™) application that will be implemented for in-situ thermal treatment (ISTT) at the Third Site located in Zionsville, Indiana (Site). The treatment volume delineated for ET-DSP™ application consists of the Dense Non-Aqueous Phase Liquid (DNAPL) Containment Area (DNAPL Area), with an approximate areal extent of 5,611 square feet (ft^2), that extends from 0 to 40 feet (ft) below ground surface (BGS); and the Additional Thermal Treatment (ATT) Area, with an approximate areal extent of 1,070 ft^2, that extends from 7 to 17 ft BGS. The total estimated treatment volume is 8,709 cubic yards (yd^3). The primary goals of the thermal treatment application are to reduce chlorinated volatile organic compound (CVOC) concentrations in groundwater to below the project-specific clean up goals and remove CVOC mass within the source zone.

During remedial activities, 77 ET-DSP™ electrodes in 33 borings will heat the treatment volume to the target temperature of 100 °C. The cumulative energy input to the electrodes is expected to be approximately 1,837 megawatt hours (MWh) and site-wide water injection to the electrodes is estimated to be at a rate of 7.7 gallons per minute (gpm). Active heating operations are expected to run for approximately 180 days.

Vaporized CVOCs and steam generated at elevated subsurface temperatures will be captured with 24 multiphase extraction (MPE) wells installed throughout the treatment volume. The total vapor flow is estimated at 125 standard cubic feet per minute (scfm) under an applied vacuum of 8 inches of mercury (in Hg). The estimated liquid extraction rate from the treatment volume is 8.0 gpm. Extracted fluids will be processed in an above ground treatment system before reinjection with excess being discharged to Finley Creek.

Performance monitoring during the ET-DSP™ application will include the deployment of 132 digital temperature acquisition module (digiTAM™) sensors in eleven (11) vertical locations, one (1) vacuum monitoring well, and measurements of fluid flow and electrical power throughout the application. All data will be available on a secure webpage for remote monitoring. Cumulative mass removal in the extracted fluids will be monitored, and after shutdown, confirmation groundwater sampling will be performed to ensure that performance goals are achieved.

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Acronyms

1,1,1-TCA	1,1,1-Trichloroethane
amsl	Above Mean Sea Level
AS	Air Sparging
ATT	Additional Thermal Treatment
AWG	American Wire Gage
BGS	Below Ground Surface
C	Centigrade
cis-1,2-DCE	cis-1,2-Dichloroethene
COC	Contaminant of Concern
CVOC	Chlorinated Volatile Organic Compound
digiTAM™	Digital Temperature Acquisition Module
DNAPL	Dense Non-Aqueous Phase Liquid
EAM	Enforcement Action Memorandum
EC	Electrical Conductivity
EPA	Environmental Protection Agency (U.S.)
ERH	Electrical Resistance Heating
ET-DSP™	Electro Thermal Dynamic Stripping Process
FSP	Field Sampling Plan
GAC	Granular Activated Carbon
gpm	Gallons Per Minute (U.S.)
HASP	Health and Safety Plan
HPT	Hydraulic Profiling Tool
Hg	Mercury
IDEM	Indiana Department of Environmental Management
IDW	Investigation Derived Waste
in Hg	Inches of Mercury

IPS	Interphase Synchronization
ISTT	In Situ Thermal Treatment
KCl	Potassium Chloride
kVA	kiloVolt-Ampere
kWh	kiloWatt-Hour
LAN	Local Area Network
LDB	Large Diameter Boring
LNAPL	Light Non-Aqueous Phase Liquid
Mc^2	McMillan-McGee Corp.
MCL	Maximum Contaminant Levels
mg/L	Milligrams per Liter
MIP	Membrane Interface Probe
MPE	Multiphase Extraction
MWh	MegaWatt-Hour
NAPL	Non-Aqueous Phase Liquid
NPDES	National Pollutant Discharge Elimination Plan
NPT	National Pipe Thread
O&M	Operations and Maintenance
OD	Outer Diameter
PCE	Tetrachloroethene (Perchloroethene)
PDP	Power Distribution Panel
PDS	Power Delivery System
PEX	Polyethylene with Cross-Links
PFD	Process Flow Diagram
P&ID	Piping and Instrumentation Diagram
PID	Photo Ionization Detector
PRGS	Permeable Reactive Gate System
PRP	Potentially Responsible Party

PSI	Pounds Per Square Inch
PTFE	Polytetrafluoroethene
®	Registered Trademark
QAPP	Quality Assurance Project Plan
RDR	Remedial Design Report
SAP	Sampling and Analysis Plan
scfm	Standard Cubic Feet Per Minute
SDS	Safety Data Sheet
SMP	Site Management Plan
SRGT	Silicone Rubber Glass Fiber Tube
SVE	Soil Vapor Extraction
USEPA	United States Environmental Protection Agency
TBD	To Be Determined
TCE	Trichloroethene
TDC	Time-Distributed Control
TDCM	Time-Distributed Control Mechanism
TM	Trade Mark
TSTF	Third Site Trust Fund
USEPA	United States Environmental Protection Agency
VC	Vinyl Chloride
VOC	Volatile Organic Compound
WCD	Well Completion Drawing
WCS	Water Circulation System
WFL	Wellfield Layout

1. Introduction

McMillan-McGee Corporation (Mc^2) has prepared this design report to describe the activities proposed for in-situ thermal treatment (ISTT) using the Electro Thermal Dynamic Stripping Process (ET-DSP™) at the Third Site in Zionsville, Indiana (Site). The activities defined in this report will be performed by Mc^2 under contract to the Third Site Trust Fund (TSTF). The scope of this document only includes ET-DSP™ remediation and/or treatment of soil, soil vapor, and groundwater contaminated with the specific contaminants of concern listed in Table 4 (Section 1.5) associated with the release(s) on the subject property within the defined treatment volume.

1.1. Work Plan for Design of ERH System at Third Site

This RDR comprises the primary document of the Remedial Action Work Plan (Work Plan) as required in the contract for ERH design, installation, operation and maintenance at Third Site. This document defines all design elements necessary to perform the work defined in the Amended Administrative Order by Consent (EPA, 2016) and Amended Enforcement Action Memorandum (EAM) (EPA, 2016B). The design includes all components to implement ERH remediation for the defined thermal treatment areas of Third Site, including an ERH system using Mc^2 ET-DSP™ technology, multiphase extraction and treatment system, monitoring equipment, and infrastructure associated with the removal action.

Once the Work Plan is approved, the final version of the RDR will describe construction of the ERH components in sufficient detail to solicit bids from construction contractors. Design parameters are confirmed by the Thermal Model. The Thermal Model has been completed and the RDR reflects the simulation results. The Thermal Model report will be issued with the Final Design.

This RDR, along with the Monitoring Plan and Site Management Plan (SMP) (Mc^2, 2017) describes the actions required to meet the ERH contract requirements. The SMP includes an expeditious schedule to complete the design, construction and operation of the ERH system.

Also included in the Work Plan is the field sampling plan (FSP) and quality assurance project plan (QAPP), which are combined in the Sampling and Analysis Plan (SAP) (Mc^2, 2017), written per EPA guidelines. Sampling and analysis activities will be critical to evaluate performance of ERH remediation and determine final shut down of ERH operations.

A Health and Safety Plan (HASP) (Mc^2, 2017) is included with the Work Plan to ensure protection of public health and safety during performance of site work. The HASP provides sufficient detail to ensure safety of onsite personnel and safe operation of equipment during site activities.

The role of the various documents constituting this Remedial Action Work Plan are shown in Table 1 below.

Table 1: Documents of the Remedial Action Work Plan

Document	Purpose	Design Basis	Methodology
Thermal Model	Electrode design; Design of electrode and extraction well layout; Power inputs; Water injection rate; Groundwater extraction rate; Vapor extraction rate; Temperature rise; and Estimated contaminant recovery.	Client-supplied soil resistivity data; Client-supplied hydraulic conductivity; Client-supplied porosity data; Client-supplied hydraulic gradient data; Client-supplied contamination type and distribution data; Client-supplied lithological data; Literature values for heat capacity; Site-specific regulations and conditions; Past experience.	Finite Element Method model for electric field and power density distribution, coupled to a Finite Difference Time Domain for mass and heat transfer, with semi-analytic solutions for peripheral heat loss.
Remedial Design Report	Recovery well design; Treatment system design; Construction implementation design; Outline of operations and monitoring.	Client-supplied hydraulic conductivity; Client-supplied porosity data; Client-supplied hydraulic gradient data; Client-supplied contamination type and distribution data; Client-supplied lithological data; Site-specific regulations and conditions; Applicable codes and regulations; Past experience.	Design equations from the literature and design manuals.
Monitoring Plan	Performance monitoring of electrical and water inputs, outputs, contaminant mass recovery, accumulation, discharges, temperature rise, and energy consumption.	Site-specific regulations and conditions; Past experience.	N/A

Document	Purpose	Design Basis	Methodology
Site Management Plan	Physical construction sequencing; Physical construction methods; Traffic routing; Layout and space utilization; Security.	Site-specific regulations and conditions; Applicable codes and regulations; Past experience.	N/A
Sampling and Analysis Plan	Laboratory sampling and analysis program.	Site-specific regulations and conditions, particularly USEPA guidelines; Site goals and consequent data needs; Past experience.	N/A
Health and Safety Plan	Safe construction implementation and operations.	Site-specific regulations and conditions; Applicable codes and regulations; Past experience.	N/A

1.2. Site Background

Third Site is located at 985 South US Highway 421 near Zionsville, IN, and is on a property approximately 2 acres in size within a mixed commercial zone (SMP Drawing SMP-01). There is a residence approximately 220 ft north of the site. US Highway 421 bounds the west of the site approximately 150 ft from the combined ERH treatment area consisting of the Dense Non-Aqueous Phase Liquid (DNAPL) Containment Area (DNAPL Area) and the Additional Thermal Treatment (ATT) Area. The property line extends through Bankert Pond, which also bounds the north perimeter of the DNAPL Area. The Envirochem Superfund Site is approximately 150 ft north of the site, and the Northside Sanitary Landfill is approximately 350 ft to the east and northeast of the site. Finley Creek forms the southeast portion of the site and flows to the southwest. (EPA, 2002)

Historical site information and the environmental impacts associated with the current ERH treatment area of the site are described in the Administrative Order by Consent (EPA, 2002) and the DNAPL Area Supplemental Data Collection Report (Environ, 2014). Environ, on behalf of TSTF, performed various remedial actions at the Site pursuant to the 2002 Order. The Order provided for implementation of a DNAPL treatment and containment system, and a groundwater pump and treatment system, in the dense non-aqueous phase liquid (DNAPL) Containment Area (DNAPL Area). The Order also provided for implementation of a Soil Vapor Extraction (SVE) system in areas identified outside of the DNAPL Area.

A sheet pile wall and local pumping was implemented to treat and contain the DNAPL Area following the approval of the 2004 Design Report (Environ, 2004). Environ also performed supplemental chemical oxidation treatment in the DNAPL Area as proposed in the 2008 Memorandum (Environ, 2008). Extraction and treatment activities were most recently completed during the fall of 2012 to spring of 2013. Confirmation sampling of groundwater completed in June 2013 showed that the remedial objective had not been met. Based on the levels of contaminants remaining within this area, enhancements to the existing remedy were requested (Environ, 2014).

The SVE system was installed and operated in impacted areas external to the DNAPL Area pursuant to the 2004 Design Report (Environ, 2004). Excavation of impacted soil from the portion of Third Site designated SVE Area 1 was completed in 2012 (Environ, 2012). As of 2014, the remedial objectives were achieved for the SVE areas. However, an impacted area below the treated vadose zone of SVE Area 1 was identified for further treatment. This area is designated as the Additional Thermal Treatment (ATT) Area, to be included in the enhancement to the existing remedy requested for the DNAPL Area.

In December 2016, EPA approved application of ERH technology for remediation of the DNAPL Area and the ATT Area. At that time Mc^2 initiated design for installation, operation, and maintenance of ERH remediation of the identified treatment areas.

1.3. Site Conditions

The Site is located north of the Finley Creek, which flows west from the site into Eagle Creek approximately one-half mile from the site. The Site includes a man-made recreational pond.

The ERH treatment areas are relatively level and grass covered. North of these areas the property is also clear of obstructions with more variable ground level. A gravel road crosses the site, entering from the north and providing construction vehicle access the DNAPL Area. To the south and east there is dense vegetation, including trees, in particular adjacent to Finley Creek and the unnamed drainage ditch.

The DNAPL Area has an area of 5,611 square feet (ft^2), which extends from the ground surface to a depth of 40 ft below ground surface (BGS), and is fully enclosed by sheet pile walls. The ATT Area has an area of 1,070 ft^2, which extends from 7 to 17 ft BGS. The total volume of the subsurface that will be heated is approximately 8,709 cubic yards (yd^3).

1.4. Site Geology and Hydrogeology

1.4.1. Geology

The general stratigraphy within the DNAPL Area consists of three primary units generally referred to as the upper till, the sand/gravel unit, and the lower till. The upper till is a predominantly fine-grained matrix with sand and silty sand seams that are not laterally extensive. The lower till is also predominantly fine-grained matrix with a higher percentage of silt and clay. The top of the sand/gravel unit underlying the upper till ranges from approximately 13 to 22 ft BGS. This unit is generally approximately 10 ft thick within the DNAPL Area, with the base of the sand/gravel unit ranging from 25 to 31 ft BGS. The sand/gravel unit is predominantly well graded sand with very little fine-grained material. It is, however heterogeneous with seams of poorly graded gravel that are not laterally extensive.

As illustrated in the wellfield layout drawing (Appendix C, WFL-02), a portion of the DNAPL Area extends out into Bankert Pond. When the sheet pile wall was installed in the DNAPL Area in 2004 the area that was formerly within Bankert Pond was replaced with clean fill material. Soil boring investigations show that this fill material is poorly graded sand with silt with a color (reddish brown) not encountered in native materials onsite. Soil borings also encountered a black organic material resembling pond bottom sediments. The history of any changes in the size and shape of Bankert Pond are not known, and this organic material likely represents the pond floor prior to the construction of the DNAPL Area.

Results of sieve analysis indicate that the upper and lower till units are predominantly fine grained, but still contain notable quantities of coarser materials. Sample collection from the sand/gravel unit indicates that the unit is well graded, with approximately 68% sand ranging from fine to coarse grained, 25% gravel, and only approximately 7% fines. (Environ, 2014).

The ATT area of the treatment volume is contained within the upper till unit of the site stratigraphy. The upper portion of the ATT zone was subject to vadose soil excavation activity in 2012. Contaminated soils were excavated to a depth of approximately 7 ft BGS and the area was backfilled with top soil. Below the fill material is native soil, predominantly clay with 5 to 15% fine sand. Within the clay there is a seam of coarser soil near 10 ft BGS, varying from fine sand to gravel, 2 to 3 ft in thickness (Environ, 2012).

Estimated soil properties from Site data for the treatment volume are summarized in Table 2. Hydraulic conductivity values were obtained as described in Section 1.4.2. Thermal conductivity values are approximated from typical values of the observed soil matrices. Electrical resistivity values are taken from the Kemron report (Appendix A).

Table 2: Estimated Soil Properties in the Treatment Volume

Depth (ft BGS)	Hydraulic Conductivity (ft/day)	Thermal Conductivity (W/m·K)	Electrical Resistivity (Ω·m)	Soil Matrix	Description
ATT Area					
0.0-7.0	8.6	1.13	34	Sandy Loam	Vadose / Backfill
7.0-8.5	18.0	1.40	34	Clay (5-15% Fine Sand) / Fine/Medium/Silty Sand	Vadose / Upper Till
8.5-10.0	18.0	3.22	90	Gravel (10% fine sand) / Clay	Saturated / Gravel Lens
10.0-15.0	18.0	1.36	27	Clay/Silty Clay	Saturated / Upper Till
15.0-17.0	62.0	5.03	82	Gravelly Sand	Sand/Gravel Unit
DNAPL Containment Area					
1.0-6.0	18.0	1.32	93-160	Silty Clay	Upper Till Vadose Zone
6.0-24.0	37.2	2.15	16-93	Silt / Sandy Silt	Upper Till Saturated Zone
24.0-31.0	62.0	5.03	17-23	Gravelly Sand	Sand / Gravel Unit
31.0-40.0	8.6	2.00	17	Silt	Lower Till

1.4.2. Hydrogeology

The historic groundwater level at the site typically ranges from 7-15 ft BGS. Groundwater level monitoring at well MW-27R by Environ from 2012 to 2015 indicated the groundwater depth in the ATT area varied from 9.8 to 11 ft BGS as shown in Table 3.

In 2014 the depth to water was measured at approximately one foot BGS in the DNAPL Area. The sheet pile wall surrounding the DNAPL Area creates a barrier restricting the flow of groundwater out of the DNAPL Area, such that water that infiltrates into the subsurface has no discharge point. Groundwater levels had risen considerably since pumping operations stopped in early 2013 (Environ 2013A).

The steel construction of the sheet pile in contact with Bankert Pond will act as a heat sink for ERH treatment, which is considered in the Thermal Model (Appendix B). The sheet pile construction is compatible with the elevated soil temperatures expected during ERH operations. The integrity of the sheet pile will be monitored by maintaining the net extraction/injection ratio, measuring water levels weekly, and evaluating the recharge rate within the sheet pile relative to historical data.

The groundwater flow gradient immediately south of the DNAPL Area and ATT area is toward the southwest. The sheet pile wall will limit the effect of the groundwater flow gradient in the DNAPL Area.

Table 3: Groundwater Depth in ATT

Groundwater Elevation Data
Third Site Superfund Site, Zionsville, Indiana

Well Number	Top of PVC Elevation (feet AMSL)	Screen Interval (feet bgs)	Date	Depth to Water (feet)	Water Elevation (feet AMSL)
MW-27R	882.15	6.2 - 11.2	8/28/2012	9.85	872.30
			5/19/2014	9.97	872.18
			8/25/2014	10.93	871.22
			12/15/2014	10.31	871.84
			3/6/2015	10.45	871.70
			6/8/2015	9.82	872.33
			9/22/2015	11.03	871.12

Various hydraulic conductivity measurements have been performed at the site by Environ since 2000. Based on these data, hydraulic conductivity values applicable to the treatment volume have been identified as listed in Table 2 (Refer to Table D-2 of Environ, 2004 and Appendix F of Environ, 2014). These values also correspond with the Hydraulic Profiling Tool (HPT) survey conducted by Columbia Technologies in the DNAPL Area (Appendix A of Environ, 2014).

The primary effect of hydraulic conductivity at the Site is the cooling impact of groundwater flow in the ATT corresponding to higher hydraulic conductivities. Hydraulic conductivity also affects convective heat transfer due to water injection at the electrodes, and mobilization rates of groundwater and DNAPL to the extraction wells. All these effects are simulated in the Thermal Model (Appendix B – Thermal Model). As explained in the Thermal Model, the hydraulic conductivity typically increases in silts and clays by at least an order of magnitude as target temperature is achieved during ERH treatment, and dramatically improves mobilization pathways.

Based on measures of hydraulic conductivity for the sand/gravel unit of 62 ft/day, a hydraulic gradient of 0.01 feet/foot, and a porosity of 0.23 in the treatment volume (Environ, 2004), the maximum groundwater flow velocity is estimated at 2.5 ft/day in the ATT. This conservative estimate of groundwater flow velocity will have a significant impact on heating performance and is addressed in the Thermal Model for the design and operation of the ATT electrodes. This resulted in tighter electrode spacing to allow a large contingency for electrical heating input in the ATT Area. Similarly, the expected groundwater flow velocity in the upper till unit is approximately 0.7 ft/day, which has also been addressed in the Thermal Model.

From Environ's "Third Site Field Investigation Data Report" (January 2000), the average hydraulic conductivity for the upper till (including sand lenses) is reported as 3.2×10^{-2} ft/min. However, MW-19A (screened to about 12 ft BGS) was bailed dry.

In Environ's "DNAPL Containment Area Supplemental Data Collection Report" (November 17, 2014), there are two piezometers installed in the upper till, STP-1 and STP-2, that were screened from 13 to18 and 7 to 10 ft BGS, respectively. The average hydraulic conductivities of STP-1 and STP-2 were 5.03×10^{-6} and 1.34×10^{-3} cm/sec, respectively.

The porosity is estimated to be 0.23, and gradient estimated to be 0.01 ft/ft.
The above hydraulic conductivity estimates and estimate of gradient and porosity gives a range of velocities:

$(3.2 \times 10^{-2}$ ft/min*0.01ft/ft)/0.23 = 1.39×10^{-3} ft/min or about 2 ft/day
$(5.03 \times 10^{-6}$ cm/s*0.01ft/ft)/0.23 = 2.19×10^{-7} cm/sec or about 0.0006 ft/day
$(1.34 \times 10^{-3}$ cm/s*0.01ft/ft)/0.23 = 5.83×10^{-5} cm/sec or about 0.16 ft/day

The 2000 report likely overstates the average hydraulic conductivity as it reflects some wells screened in sand lenses. The 3.2×10^{-2} hydraulic conductivity value is very unlikely in the soil types identified above the sand/gravel unit at 15 ft BGS. A value of 0.7 ft/day was used in the design model for 8.5 to 15 ft BGS range (below the water table).

Thus, there is a large contingency for heating power input in the ATT area, which can be further increased by performing KCl injection. Up gradient or treatment area steam injection wells are an option to improve subsurface heating if the monitored thermodynamic response is not adequate in the ATT relative to behavior predicted by the Thermal Model.

The effective porosity of samples collected from the upper till unit ranged from 20% to 24%. Similar porosities are expected in the lower till unit based on similar soil composition. This effective porosity combined with the hydraulic conductivity values in the till units show that even though the upper till may contain notable percentages of coarse grained material, the pore space is minimally interconnected and the permeability is low. There is contingency for higher porosities, and resulting proportion of groundwater, in the till layers since the electrode spacing is determined by the higher resistivity and porosity of the sand/gravel unit. The effective porosity of samples collected from the sand/gravel unit ranged from 42% to 47% and suggests preferential groundwater flow in this lithologic unit (Environ, 2014). If the porosity of the sand/gravel unit is lower than the measured values, this would likely improve ERH performance due to a lower proportion of groundwater to heat in this layer.

Porosity often corresponds with hydraulic conductivity and associated effects as described above. The proportion of water in the soil volume affects the heating energy due to higher heat capacity as described in Appendix B. Porosity is also a factor in determining electrical resistivity, and thus the electrical heating power levels that may be maintained at the ERH electrodes.

1.5. Contaminant Distribution and Remedial Goals

1.5.1. Contaminant Distribution

Overall, the soil and groundwater throughout the majority of the DNAPL Area is impacted with volatile organic compounds (VOCs), with the greatest impacts primarily in the central portion of the containment area. Maximum total VOC concentrations were detected within the upper till at an approximate depth of 6 to 13 ft BGS. Of note, minimal soil impacts were identified in the "wedge" of fill soil placed to level the northern portion of the containment area where it extends out into Bankert Pond. However, the groundwater that is present within this sand fill "wedge" is impacted with VOCs above 4,285 µg/L total VOC concentration. Total VOC concentrations are approximately one to two orders of magnitude less in the southern portion of the DNAPL Area than to the north. In most locations in the central portion, the impacts are mostly throughout the upper till unit and the underlying sand/gravel unit. Samples collected from within the lower till underlying the sand/gravel unit exhibit minimal VOC impacts.

The predominant compounds of concern found in the VOC-impacted soil and groundwater are trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and 1,1,1-trichloroethane (1,1,1-TCA). TCE breakdown products, primarily cis-1,2-DCE and vinyl chloride (VC), are more prevalent than TCE in the southern portion of the DNAPL Area, where total VOCs are much lower. Table 4 lists the contaminants of concern and their maximum detected concentrations (Table 1, Environ, 2014).

Total VOC concentrations are indicative of residual DNAPL in the subsurface, and DNAPL was recovered during data collection activities in 2014. The total volume of possible NAPL remaining in the DNAPL Area is estimated to be 154 ft^3 (1,151 gallons), and the total possible mass of non-aqueous phase liquid (NAPL) is estimated to be 13,149 pounds. The majority of the maximum VOC impacts and probable NAPL are present in the upper silt layer of the upper till unit and the upper portion of the lower sand layer of the sand/gravel unit with approximate volumes of 61 ft^3 and 57 ft^3 respectively. Analysis of the recovered NAPL sample indicates primary constituents are 58.5% TCE and 16.3% 1,1,1-TCA by molar weight. The remaining 25.2% is a combination of 8 other contaminants of concern (COCs). (Environ, 2014).

Table 4: Maximum COC Concentrations

Contaminant of Concern	Maximum Detected Soil Concentration (mg/kg)	Maximum Detected Groundwater Concentration (mg/L)
1,1-Dichloroethane	39.8	27.7
1,1-Dichloroethene	3.3	1.4
cis-1,2-Dichloroethene	292	131
trans-1,2-Dichloroethene	8.4	5.3
Tetrachloroethene	503	9.2
1,1,1-Trichloroethane	1,160	195
1,1,2-Trichloroethane	0.6	0.5
Trichloroethene	4,020	627
Vinyl Chloride	5.8	3.3
Total VOCs	**6,912**	**931.6**

The ATT Area has lower concentrations of contamination than the DNAPL Area. Available soil VOC data are from shallower vadose soils (< 7 ft BGS). These shallower soils were excavated in 2012 and are not targeted for additional remedial action. Per client information the treatment depth in the ATT zone will extend from the 7 ft BGS excavated depth to the assumed bottom of the upper till at 17 ft BGS. Groundwater sample analysis for MW-27R in 2015 indicates concentrations of cis-1,2-DCE and VC well in excess of groundwater action levels, and a total VOC concentration of 3,674 µg/L (EPA, 2016B). Investigations for remedial action of the DNAPL Area determined that DNAPL was not present outside of sheet pile (Environ, 2003).

1.5.2. Remedial Goals

The overall treatment objective at the Site is to protect human health and the environment by mitigating contaminant exposure and preventing contaminant migration to the surrounding environment. The remedial goal for the ERH Remedial Action is to achieve a minimum 90% reduction in total VOC groundwater concentration within the DNAPL Area[1] (sheet-pile enclosed area) and the ATT

[1] Remedial objectives for the DNAPL Area are identified in Section VI.a of the May 11, 2001 USEPA EAM. These objectives have been subsequently clarified in USEPA approved documents prepared by Environ including the

Area[2] (small area outside of the sheet pile enclosed area) following ERH treatment. The COCs contributing to the total VOC concentration in groundwater are identified in Table 4.

In the DNAPL Area, this reduction is to be measured through the collection of groundwater samples from the centrally located extraction well (Sump) and surrounding three piezometers P-1 to P-3. On receipt of analytical results from the laboratory, the analytical results for each of the three piezometers are to be summed to calculate the total VOC concentrations in each piezometer. In the event of any significant difference between (a) the average of the total VOC concentrations in the three piezometers, and (b) the total VOC concentration in the extraction well (Sump), the parties will confer and evaluate whether the results for the extraction well (Sump) are reasonably representative of dissolved-phase conditions within the DNAPL Area. Treatment of the DNAPL Area will be considered complete when the total VOC groundwater concentration in the DNAPL Area is less than or equal to 4,285 micrograms per liter (µg/L), the value that is equal to 10% of the baseline total VOC groundwater concentration measured in January 2005 and reported to EPA in February 2005.

Reduction in total VOC groundwater concentration for the ATT Area is to be measured through the collection of groundwater samples from the monitoring well MW-27R. Contaminant of concern laboratory analytical results for this well are to be summed to calculate total VOC concentration in groundwater at the location. Treatment of the ATT Area will be considered complete when the total VOC groundwater concentration in monitoring well MW-27R is less than or equal to 742 µg/L, the value that is equal to 10% of the baseline total VOC groundwater measured in March 2017 and reported to EPA in the April 2017 Monthly Progress Report for Third Site.

Refer to Table 5 for a summary of performance standards for contaminant mass concentration reduction during ERH treatment.

March 17, 2004 Design Report for the Non-Time Critical Removal Action at Third Site-2nd Revision (Section II.C.5) (Environ 2004), January 2005 base line sampling data, February 20, 2008 Memorandum In Situ Chemical Oxidation Confirmatory Ground Water Sampling DNAPL Containment Area from Environ to EPA (Environ 2008A), and December 31, 2008 Proposed Confirmatory Groundwater Sampling memorandum (Environ 2008B). Remediation contemplated for the DNAPL Area at the time the above referenced EAM and subsequent documents were prepared was focused on pump & treat and chemical oxidation. USEPA has subsequently approved ERH to remediate the DNAPL Area as per the December 12, 2016 Amended EAM (EPA 2016B) and December 12, 2016 Amended Administrative Order by Consent (EPA 2016A).

[2] The remediation treatment for the ATT Area is the groundwater pump and treat system. The objectives for the groundwater pump and treat system are established in Section VI.c of the May 11, 2001 USEPA EAM and the March 17, 2004 Design Report for the Non-Time Critical Removal Action at Third Site-2nd Revision (Section II.E.5), prepared by Environ (Environ 2004). Since the purpose of the ERH treatment of the ATT Area is to expedite meeting of the groundwater pump and treat remedy in that area and a 90% of total VOCs reduction in that area will have that effect, the 90% reduction criteria will be based on groundwater sample total VOC analysis for monitoring well MW27R, performed on March 22, 2017. Refer to the Ramboll April 2017 Monthly Progress Report for Third Site.

Table 5: Performance Standards for ERH Treatment

Treatment Area	Sampling Location	Measurement	Performance Goal
DNAPL Area	Sump, P-1, P-2, and P-3 Wells	Total VOC Concentration in Groundwater	4,285 µg/L
ATT Area	MW-27R Monitoring Well	Total VOC Concentration in Groundwater	742 µg/L

The operational objectives at the Site are to:

1. Heat the treatment volume to a target temperature of 100 °C (the boiling point of water) in approximately 55 days (based on the Thermal Model); and,
2. Prevent further mobilization of COCs to areas outside of the limits of the target treatment area by maintaining pneumatic and hydraulic control of the treatment area.

In addition to the overall treatment objectives listed above, there are several operational goals that include the following:

1. Maintaining system uptime of 95% or more;
2. Achieving subsurface temperatures at the boiling point of water through all of the temperature sensors in the treated volume; and,
3. Reaching CVOC concentration shutdown criteria in the treatment system influent, and verifying that groundwater sample data indicate performance criteria have been met in accordance with the afore-mentioned goals.

1.6. Project Schedule

A project schedule describing the timeline of the main project milestones is provided in the Site Management Plan (Mc² 2017). Table 6 shows a summary of the major project phases.

Table 6: Approximate Duration of Project Phases

Phases	Approximate Duration	Projected Start Date
Subsurface Construction	32 days	August 18, 2017
Above Ground Construction	25 days	September 11, 2017
Acceptance Testing	14 days	October 16, 2017
Heating Operation	180 days	October 27, 2017
Cooling/Compliance Sampling Period	90 days	May 21, 2018
Demobilization	27 days	September 24, 2018
Final Report	50 days	November 5, 2018

1.7. Project Organization

The thermal remediation team consists of TSTF representatives, Mc², MK Environmental (MK), and other construction and operations subcontractors. The general organization and roles of the parties involved are outlined in Site Management Plan (Mc², 2017). Table 7 summarizes the key personnel for the Third Site ERH project.

Table 7: Project Organization

Organization	Role	Contact	Role	Contact Information
U.S. Environmental Protection Agency (US EPA)	Regulatory Lead	Matthew Ohl	Remedial Project Manager	(W) 312-886-4442 ohl.matthew@epa.gov
		Warren Layne	QA/QC Officer	(W) 312-886-7336 layne.warren@epa.gov
Third Site Trust Fund (TSTF)	Client	Norman W. Bernstein	Trustee	(W) +1 914-358-3500 nwbernstein@nwbllc.com
		Peter M. Racher	Trustee	(W) +1 317-637-0700 pracher@psrb.com
August Mack Environmental (AME)	Trust's Engineer	Scott Randall	Sr. Project Manager	+1 317 453 7983 srandall@augustmack.com
		Chris Turley	Field Technician	+1 765-271-5471 cturley@augusmack.com
Ramboll Environ	Groundwater Sampling	Andrew Gremos	Sampling Contractor	(W) +1 317-803-4605 (M) +1 317-213-4352 agremos@ramboll.com
McMillan-McGee Corp. (Mc²)	ET-DSP™ Thermal Contractor	Brent Winder	Project Manager	(W) +1 403-569-5103 (M) +1 403-589-8726 bwinder@mcmillan-mcgee.com
		David Rountree	Resident Engineer	(W) +1 403-569-5116 (M) +1 403-921-0848 drountree@mcmillan-mcgee.com
		Eric Ringdahl	Project Engineer	(W) +1 403-569-5102 (M) +1 403-863-8462 eringdahl@mcmillan-mcgee.com
		Wayne Robella	H&S Manager	(W) +1 403-569-5106 (M) +1 403-461-1669 wrobella@mcmillan-mcgee.com
		TBD	System Operator	TBD
MK Environmental (MK)	Treatment Equipment Contractor	Edward Tung	Owner / Engineer	(W) 630-920-1104 (M) 630-848-0585 etung@mkenv.com
		Mark Loeffler	Design Engineer	(W) 630-920-1104 (M) 262-308-1444 mloeffler@mkenv.com
		Nick Marnach	Project Engineer	(M) 605-929-6888 nmarnach@mkenv.com
HD Sonic Drilling	Drilling Contractor	James Nidzgorski	Project Manager	(W) 330-426-9507 jnidzgorski@hdsonicdrilling.com

Organization	Role	Contact	Role	Contact Information
West Electric	Electrical Contractor	Ron Miller	Project Manager	(W) 765-643-6444 ron@westelectricinc.com
Pace Analytical Services	Laboratory Service	TBD	Project Manager	TBD
TBD	QA/QC Contractor	TBD	QA/QC Officer	TBD

1.8. Design Basis

The site characterization data summarized in Sections 1.2 through 1.5 forms the basis for the final ERH design. This design was based on the results of drilling investigations, monitoring well installations, electrical resistivity testing, membrane interface probe (MIP) characterization, and hydraulic tests. The site data includes information on historical contaminant impacts and remediation efforts, current site conditions, geology and hydrogeology, and contaminant distribution.

An important parameter that governs the electrical resistance heating component of the ET-DSP™ heat transfer process is the electrical resistivity of the soil. Soil samples collected from two borings at the Site, collected at various depth intervals within the proposed treatment volume, were evaluated by Kemron Environmental Services between October 5th and 7th, 2015 using static (i.e., constant temperature) resistivity tests, which are used to determine the general power requirements during ET-DSP™. The static resistivity of the samples ranged from 16 to 160 Ω·m (the Kemron report is provided in Appendix A). Mc^2 requested the electrical resistivity characterization effort, accepted Kemron to perform this work, and determined that the data provided was acceptable as an ERH design basis.

2. Treatment Technology

A full-scale ET-DSP™ application will be implemented for thermal treatment at the Site. VOC vapors produced in the subsurface will be captured with multiphase extraction (MPE) wells and processed in an above ground treatment system before discharge. ET-DSP™ is a patented electrothermal technology (United States patent number 6,596,142; Canadian patent number 2,341,937) where the power input to individual electrodes is controlled and water recirculation is used to enhance convective heat transfer. These processes can result in a more uniform temperature distribution earlier into an application than other ISTT technologies (McGee and Donaldson, 2009).

2.1. ET-DSP™ Heat Transfer Mechanisms

Field applications of ET-DSP™ use a Power Delivery System (PDS) to direct low frequency (60-Hertz) three-phase electrical power to a network of subsurface electrodes. Adjacent electrodes are 120° out of phase such that gradients in electric potential are induced, which causes current conduction and resistive heat dissipation throughout the treatment volume. The power dissipated by electrical resistance heating is proportional to the inverse of the radius squared from each electrode (McGee and Donaldson, 2009). Water injection during ET-DSP™ compensates for this non-uniform power distribution by increasing convective heat transfer, which propagates heat further from the electrodes into the subsurface. Conductive heat transfer also occurs because of the temperature gradients induced during heating. The transient temperature distribution during ISTT is dictated by the conservation of energy, which can include conduction, convection, electrothermal, phase change and heat accumulation terms (McGee and Vermeulen, 2007).

2.2. ET-DSP™ Mass Removal Mechanisms

At elevated temperatures, vaporization, volatilization, dissolution, and desorption are enhanced such that conditions are more favorable for the extraction of VOC mass from the subsurface (e.g., USACE, 2009; Triplett Kingston et al., 2014). These mechanisms are described by the temperature dependence of the vapor pressures, Henry's law constants, solubilities and soil-water partition coefficients for the fluids in question, respectively. In addition, liquid viscosities, interfacial tensions, and densities decrease at elevated temperatures, which can make NAPLs more mobile for extraction.

Vaporization (i.e., boiling of immiscible VOCs and groundwater) and volatilization (i.e., partitioning of VOCs from the dissolved phase to the gas phase) are the most dominant mass removal mechanisms during ET-DSP™. As such, extraction wells must be designed for effective gas capture, with appropriate locations, screened intervals, and applied vacuums, in order for performance to be successful. Detailed geological and hydrogeological site characteristics were incorporated into the site Thermal Model (Appendix B – Thermal Model) to optimize this design.

Figure 3.12 of the Thermal Model (Appendix B) presents a simplified representation of subsurface pressure behavior. The actual water table would have a superimposed cone of impression at the electrode well and a cone of depression at the extraction well. For the purpose of calculation of bubble phase capture, this is represented as a pressure gradient towards the extraction well. The local upwelling at the extraction well is neglected as the contaminants at that point will be captured with the liquid phase or rise to the vadose zone and enter the extraction well. Based on experience with numerous sites, this calculation based on a simplified model results in a radius of capture that provides well spacing suitable for design of the extraction system. The vapor extraction rate at the well is determined from the well spacing to ensure vapor phase contaminants in the vadose zone are swept to the extraction wells, and to provide sufficient overall vapor extraction to maintain pneumatic control of the treatment volume. Similarly, the liquid extraction rate at each well is determined from the well spacing to ensure hydraulic control is maintained in the treatment volume and mobilized liquid phase contaminants are captured.

2.3. ET-DSP™ Subsurface Vapor Generation

The placement and operation of ET-DSP™ electrodes and extraction wells are designed such that sufficient temperatures will be achieved to vaporize COCs in the source zone. Vaporization occurs when the total gas pressure, given as the sum of the partial vapor and dissolved gas pressures, exceeds the sum of the ambient atmospheric, hydrostatic, and capillary pressures. Consequently, boiling points increase with depth below the water table and vary with lithology.

When NAPL is present, gas production first occurs at the water co-boiling (i.e., steam distillation, heteroazeotrope) temperature, since vapor pressures are additive at immiscible fluid interfaces (e.g., Dalton's Law). Fractional distillation theory governs the composition of the vapor phase. Co-boiling continues until all the NAPL vaporizes, and capture of the resulting vapors can represent a significant amount of the total VOC mass extracted. For multicomponent NAPL mixtures, the more volatile components vaporize preferentially, and both the composition of the NAPL and the co-boiling temperature change over time (e.g., Raoult's Law). Gas bubbles are generated at NAPL-water interfaces during co-boiling and propagate upwards as buoyancy forces overcome capillary trapping forces. Subsurface heterogeneities influence the path of co-boiled vapor bubbles towards extraction wells below the water table.

The primary chlorinated solvent at the Site is TCE, which has a water co-boiling temperature of 73°C. Other major COCs include cis-1,2-dichloroethane and 1,1,1-trichloroethane, with lower water co-boiling temperatures of 54°C and 65°C, respectively. Other COCs present also have pure phase boiling temperatures below target temperatures and will be readily vaporized during ISTT operation. The actual co-boiling temperature of NAPL mixtures at the Site will depend on the precise composition of these mixtures.

Continued temperature increase to the groundwater boiling point during ET-DSP™ operation generates a significant amount of steam throughout the subsurface, which facilitates the transport of any remaining VOC vapors towards extraction wells. In addition, steam generation allows for increased volatilization and dynamic stripping of dissolved constituents, which can be an important mechanism to reduce VOC concentrations in the source zone.

Gas transport during ET-DSP™ is influenced by pressure gradients due to the vacuum applied at subsurface extraction wells. A proper vapor cap provides a no-flow boundary condition at the top of the treatment zone, which assists vapor flow through the vadose zone towards extraction wells. In lower permeability media, steam formation also has the potential to create a secondary porosity for Taylor bubble flow (McGee et al., 2004) as an additional transport mechanism for VOC mass towards extraction wells.

In the final stages of operation, pressure cycling can be performed as a strategy to create new gas pathways and remove mass in regions where vapors might be trapped. This technique involves varying individual electrode power inputs and applied vacuums such that regions of the subsurface are pressurized and depressurized.

Subsurface temperatures are monitored in real time during an ET-DSP™ application to identify the vapor generation response (i.e., changes in the rate of temperature increase, indicating regions of sensible or latent heat), as well as to inform the operation of the electrodes and water circulation system (WCS) units.

2.4. ET-DSP™ Conceptual Design

The conceptual schematic shown in Figure 1 illustrates the main processes that are involved in an ET-DSP™ application.

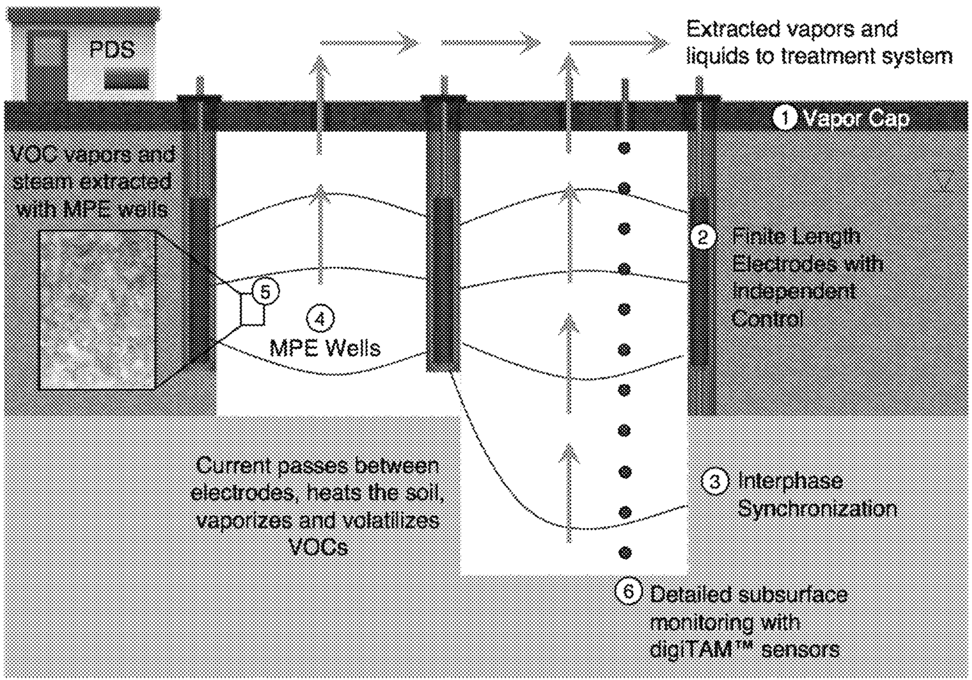

Figure 1: General Approach Using ET-DSP™ (not to scale)

Element 1 : The treatment area is covered with a vapor cap extending 10 feet beyond the electrode grid that consists of existing concrete and asphalt surfaces in combination with an additional cellular concrete pad. The vapor cap is critical for maximizing vapor capture and minimizing heat loss in the vadose zone. It also limits infiltration and short-circuiting during vapor extraction.

Element 2 : Finite length electrodes with independent control are stacked in vertical boreholes to conduct electric current throughout the vertical extent of the treatment volume. The applied electric field accelerates charge carriers in the pore water, which results in the kinetic energy transfer that causes resistive heat dissipation. The use of stacked electrodes can improve performance associated with the preferential flow of current through more conductive lithologies.

An important element of ET-DSP™ involves the injection of water at the ends of the electrodes, which enhances convective heat transfer, mitigates the dipole effect, and maintains liquid contact at the electrode surface to avoid decreased power input associated with resistive conditions during gas production. Injected water that vaporizes also enhances the dynamic stripping process. The benefit of this design is a more uniform temperature distribution throughout the treatment volume, which enables fluid transport towards the extraction wells.

Element 3 : The electric field and current path between electrodes can be controlled using Interphase Synchronization (IPS) and the electric power input to the electrodes can be varied by operators using Time-Distributed Control Mechanism (TDCM). These tools can help promote the development of a more uniform temperature distribution during ET-DSP™ operations, especially when spatial differences in electrical, thermal and hydraulic properties are encountered within a heterogeneous treatment volume.

Element 4 : Multiphase extraction wells are used to capture fluids for aboveground treatment and discharge. Downhole pneumatic pumps or slurper tubes are operated at sufficient extraction rates to maintain inward gradients for hydraulic control, as water is injected to the electrodes and vaporized liquids displace groundwater, and function as a mechanism to capture dissolved VOCs.

Element 5 : VOC vapors and steam are created at elevated temperatures in the treatment volume. Sufficient local and macroscopic connection of the vapor phase causes bubble and/or channel flow upwards towards the vadose zone and towards extraction wells for capture. Continuous operation of the extraction wells at sufficient vacuums will capture vaporized VOCs and steam for pneumatic control.

Element 6 : Continuous remote data monitoring of temperature using digiTAM™ sensors will allow operators to respond in real time to transient subsurface conditions. The data will be available on a dedicated project web page and project database.

3. Remedial Approach

The delineated treatment volume at the Site will be targeted with a combination of ET-DSP™ and MPE. The design is based on fundamental physical and thermodynamic principles, lessons learned from previous projects, the Site conceptual model, the resistivity of the soil at the Site, the ET-DSP™ Thermal Model, and the remedial objectives outlined in Section 1.3.3. The Thermal Model report for this Site will be provided with the completed Remedial Design.

Reducing total VOC concentrations in groundwater by a minimum of 90% in the monitoring well locations within the timeframe is the desired outcome of the remediation effort. While achievement of this goal will move the site closer to final remediation, any other goals are outside the scope of the ERH remediation effort. Refer to Section 1.5.2 for detailed description of the remedial goals applicable to the ERH Remedial Action.

The Thermal Model along with previous experience indicates that approximately 180 days of ET-DSP™ operations is needed to achieve the remedial objectives. The design presented herein reflects this anticipated remedial duration. Per the Thermal Model, the first 55 days of heating will ramp up the treatment volume to the target temperature range. The remaining time will be spent in maintenance mode, staying at the desired temperature, and extracting the volatilized contaminant mass.

3.1. Remedial Components

The design elements for thermal remediation of the Site are presented in Table 8. Key features are summarized as follows:

1. Thirty-three (33) electrode wells with one (1) or three (3) ET-DSP™ electrodes per well, for a total of 77 ET-DSP™ electrodes;
2. Twenty-four (24) MPE wells, screened in the vadose zone and below the groundwater table within the upper till of the defined treatment areas, and in the sand/gravel unit and lower till within the DNAPL Area;
3. Eleven (11) vertical sensor wells for temperature data acquisition and monitoring within the treatment zone. Each of the wells will have digiTAM™ sensors imbedded at approximately 3 ft intervals, for a total network of 132 temperature measurement devices. One (1) perimeter vacuum monitoring well will also be installed between the ATT Area and Bankert Pond.

The MPE wells will be used to extract vapor, liquid, and dissolved phase VOCs. Extracted fluids will be directed towards an above ground treatment system, which is specifically designed for the COCs, emissions requirements and flow rates anticipated for ISTT at the Site. The treatment system equipment will include knockout pots, phase separators, an air stripper, holding tanks, bag filters, cartridge filters, steam-regenerated and sacrificial activated carbon vessels, vacuum blowers, pumps, air compressors, cooling towers, and heat exchangers.

3.2. Technical Design Summary

A synopsis of the technical ET-DSP™ design is presented in Table 8.

Table 8: Project Technical Design

Item	Description	Comments
Site Characteristics		
Treatment Area [ft^2]	5,611+1,070	DNAPL area + ATT.
Treatment Volume [yd^3]	8,313+396	DNAPL zone at 40' + ATT 7 to 17' BGS.
Deep Extent of Treatment [ft. BGS]	40	Maximum vertical treatment interval.
Shallow Extent of Treatment [ft. BGS]	0	Treatment to below vapor cap to mitigate condensation.
Depth to Groundwater [ft. BGS]	10	ATT area (§1.4.2). DNAPL Area at 1' BGS must be dewatered on startup.
Contaminants of Concern	CVOCs	Primarily TCE, 1,1,1-TCA, cis-1,2-DCE, others present.
Mass Estimate [lbs]	20,000	As per RFP instructions.
Remedial Goal	90%	90% reduction in groundwater concentrations.
Soil Resistivity (Ω ·m)	16 -160	As measured by Kemron Laboratory.
Remedial Approach		
ET-DSP™ Electrodes	77	10' or 12' long × 8" diameter; 23 wells with 3 electrodes/boring, 10 ATT wells with 1 electrode/boring.
Power Delivery Systems [kVA]	1 x 1330 1 x 660	Web power control, 480V primary, multi-tap secondary.
digiTAM™ Temperature Sensors	132	11 strings, 12 sensors per string at 3' intervals.
Electrode Spacing [ft.]	18	Variable in places, based on measured resistivity.

Item	Description	Comments
Remedial Approach (Cont'd)		
Vacuum Monitoring Wells	1	Perimeter well installed to depth of vadose zone.
Bottom of Deep Electrode [ft. BGS]	40/17	Based on target interval for DNAPL and ATT.
Top of Shallow Electrode [ft. BGS]	3	Conductive heat transfer above. 6 ft BGS in ATT.
Vapor Cap [ft^2]	7,500	Approximately, Insulating light concrete type, R-6. Corresponds with area of thermal influence.
Target Temperature [°C]	100	Recommended design temperature for optimal COC recovery.
MPE Wells	24	4" 304 SS cont. wire wrap screen, 0.010" slot size, C/W slurp tubes.
Vapor Recovery Air Flow [scfm]	125	Estimated assuming 12' vadose and >6 pore volumes/day, 12 in Hg vacuum. Per Thermal Model.
Liquid Extraction Rate [gpm]	8.0	Maintain extraction/injection ratio.
Vapor Treatment Method	Vapor GAC	Carbon regen system.
Liquid Treatment Method	Liquid GAC	Based on mass & abatement requirements.
Summary Information		
Cumulative Power Input [MWh]	1,837	Cumulative estimate based on ~200 kWh/yd^3.
Electrical Power Input [kW]	425	Avg. for project duration, peak = 710 kW 1500 kVA, 480V, 1800 amp service
Water Demand [gpm]	7.7	~0.1 gpm/electrode, Re-circulation design
Time to Target Temperature [days]	55	Per Thermal Model.
ET-DSP™ Thermal Operations	180	Expected time to achieve all performance goals

3.3. Subsurface design

3.3.3. Target Zones

The areal extent targeted for heating will correspond to the horizontal placement of the ET-DSP™ electrodes shown in the well field layout details (WFL-02, Appendix C), which will encompass the combined treatment area. The depth interval targeted for heating will correspond to the vertical placement of the ET-DSP™ electrodes shown in the well construction details (WCD-01 and WCD-02, Appendix C), which extends from surface to 40 ft BGS in the DNAPL area, and from 7 to 17 ft BGS in the ATT area. Substantial heat transfer is expected to extend 3 ft above and below the ends of each electrode.

3.3.4. Electrodes

A total of 77 electrodes will be installed in 33 boreholes. The DNAPL area will have three electrodes installed in each of the 22 boreholes, to depths of approximately 43 ft BGS. The ATT area will have one electrode installed in each of the eleven (11) boreholes, to depths of 18 ft BGS. The electrodes will be configured as shown in the well field layout details (WFL-02, Appendix C) and constructed as shown in the well construction details (WCD-01 and WCD-02, Appendix C). The electrodes will be installed on 18 ft centers. The spacing is more variable in some locations but the 18 ft spacing will not be exceeded.

The electrode wells are designed to heat the full treatment depths, from surface (aided by the vapor cap) to 40 ft BGS in the DNAPL Area, and from 7 to 17 ft BGS in the ATT Area. The DNAPL Area electrodes extend deeper than the treatment depth to compensate for vertical heat losses and groundwater infiltration under the sheet pile.

Power levels determined by the Thermal Model indicate that the average power during ET-DSP™ operations will be approximately 425 kilowatts (kW) (5.4 kW per electrode) with a peak of approximately 710 kW (9.0 kW per electrode). The electrode power levels will be optimized during operations based on the rate of temperature increase observed in the subsurface. Once the target temperature is achieved in an area, the electrodes can be placed into a maintenance mode, during which the power is reduced while the achieved temperature is maintained.

3.3.5. Extraction Wells

A total of 24 MPE wells, complete with compressed air assisted vacuum-lift groundwater recovery (i.e. slurper) tubes, will be installed throughout the treatment volume. The extraction wells will be located as shown in the well field layout details (WFL-02, Appendix C) and constructed as shown in the well construction details (WCD-01 and WCD-02, Appendix C). The extraction wells will be screened from approximately 3 ft BGS (6 ft BGS in ATT) to the treatment depth at the well location to allow for the application of vacuum for liquid and vapor recovery.

The total design vapor recovery airflow is 125 standard cubic feet per minute (scfm) from the well field, at an average rate of 5.2 scfm per MPE well, per Thermal Model results. The treatment system will accommodate up to 200 scfm as contingency. The MPE wells are designed to be operated under a vacuum of 12 inches of Mercury (in Hg), and will be spaced according to the Thermal Model with contingency for variable site conditions, to ensure complete vacuum influence over the entire treatment volume. At boiling temperatures, steam generation is anticipated to increase the secondary permeability of the formation, leading to increased vapor flow and radius of capture. To accommodate this, the extraction and treatment system will be slightly overdesigned for the anticipated vapor flow.

3.3.6. Sensor Wells

Sensor wells will be used to monitor subsurface temperature within the treatment volume. DigiTAM™ temperature sensors will be installed in eleven (11) sensor wells, extending from surface to the treatment depth at the well location. The sensor wells will be configured as shown in the well field layout drawing WFL-02 (Appendix C) and constructed as shown in the well construction drawing WCD-01 and WCD-02 (Appendix C).

Temperature contour plots generated from the digiTAM™ data can be used to assess the relative magnitude of the various subsurface heat transfer processes, which in turn can inform operators of potential adjustments to the WCS, TDC module or other ET-DSP™ components.

DigiTAMs™ are integrated with the Mc² onsite local area network (LAN) and data will be collected automatically as part of the overall data acquisition strategy for the thermal project. Data will be monitored by the Mc² project team via the project website to evaluate heating performance of the ERH system and determine process adjustments.

3.3.7. Hydraulic and Pneumatic Control

The ET-DSP™ system is designed so that a consistent inward hydraulic and pneumatic gradient is maintained over the course of the remediation. A vapor recovery rate of six (6) vadose zone pore volumes per day will be maintained. A minimum groundwater extraction to injection ratio of 1.025 will be maintained in the ATT Area, resulting in a net inward groundwater flow, which is critical for the proper implementation of the ET-DSP™ treatment. A unity extraction to injection ratio is proposed for the DNAPL Area, which is enclosed by sheet pile to provide hydraulic control.

The overall injection rate of 7.7 gallons per minute (gpm) is based on average injection of 0.1 gpm at 77 electrodes. An extraction rate of 8.0 gpm[3] will be maintained in total from the 24 extraction wells to maintain the minimum extraction to injection ratio of 1.025. The extraction/injection ratio may be as high as 1.20 at times, depending on changes in the subsurface throughout operations. On startup of the extraction system, focused extraction in the DNAPL Area may be necessary to dewater the area enclosed by sheet pile if the initial water levels remain elevated as reported in 2014. Operational parameters for hydraulic control will be verified by the Thermal Model.

Pneumatic control is achieved by ensuring sufficient vacuum level is maintained in the wellfield during ET-DSP™ operation. Vacuum level will be recorded manually at each extraction well on a daily basis, at minimum. One (1) perimeter vacuum monitoring

[3] Capacity of treatment system shown on MK drawings will be increased in Final Design to match results from Thermal Model.

well will be installed between the ATT Area and Bankert Pond to the vadose zone depth at the location. Vacuum level will be recorded daily at this location as further verification of pneumatic control.

Prior to startup of the ERH system, the DNAPL Area will be dewatered to expose an adequate vadose zone for effective vapor recovery. After acceptance testing of the extraction and above ground treatment system, Mc² will operate the MPE wells to extract groundwater and achieve a DNAPL Area water level of approximately 10 ft BGS. Dewatering prior to ERH startup prevents heat losses due to increased liquid extraction during electrode operation.

The designed extraction/injection ratio of 1.025 will be adequate to maintain drawdown of the water levels during ERH operations given the slow recharge rate historically within the sheet pile[4]. The extraction/injection ratio will be increased if necessary. Mc² has used this approach effectively at similar sites with elevated water tables to increase the vadose recovery zone. A further option to improve capture of steam and vapor near surface is to install horizontal vapor extraction wells in a vapor plenum beneath the vapor cap. Mc² will provide a contingency design for this option for consideration prior to construction.

3.4. Above Ground Design

3.4.1. Vapor Cap

The vapor cap insulates against heat loss through the ground surface, isolates above ground components from electric potentials induced in the subsurface, prevents fugitive vapor emissions, reduces atmospheric air from short circuiting into the extraction wells, and limits heat loss associated with groundwater recharge in the vadose zone. At the Site, the vapor cap will be comprised of cellular concrete covering the two treatment areas, to act as a vapor barrier (Appendix A, Drawing WFL-02). The vapor cap will have a minimum R-value of 6 $°F \cdot hr \cdot ft^2/BTU$ and be approximately 6 inches thick. This feature will assist with maintaining high temperatures in the vadose zone and minimizing the potential for condensation of vaporized VOCs.

Cellular concrete is applied using equipment that introduces air bubbles into the concrete mix during application to the ground surface. If cracks or vapor breakthrough are observed during operations, repairs will be performed at the surface of the cellular concrete by using a QUIKRETE® concrete repair caulking gun, grouting inside larger cracks, and/or installing polyethylene sheeting.

3.4.2. Extraction System

Compressed air assisted vacuum-lift groundwater recovery slurper tubes will be used for the extraction of groundwater. The liquid extraction rate for the ET-DSP™ component of the system is designed to achieve 8.0 gpm. Recovered groundwater flow from the MPE wells will depend on and be regulated by the supplied air rate. Extraction rates at individual MPE wells will vary over the course of thermal treatment,

[4] Refer to the Third Site Monthly Progress Report, April 2013. The slow recharge rate of water level within the sheet pile was demonstrated after pumping from the DNAPL Area was discontinued on December 11, 2012.

in particular as phase change and thermal fracturing in lower permeability media occurs.

As the temperature increases the porosity of the soil changes at a thermal expansion rate. As the temperature of the liquids filling the pore space increase they will tend to expand in accordance with the coefficient of thermal expansion of the liquid. Change in porosity due to thermal fracturing during ET-DSP™ operations results in a dramatic increase in the permeability of tight soils.

The extraction system will use a high capacity, high vacuum pump (blower) to provide the driving force for vapor extraction and groundwater / soil vapor conveyance through the piping network to the treatment system. This blower can provide both high-flow, low vacuum, and low-flow, high vacuum conditions using suitable flow control valves. The vapor recovery line for the vapor extraction piping will connect to the primary liquid/vapor knockout tanks and heat exchangers to capture entrained liquids and condensate before being moved to the vapor treatment side of the treatment system.

3.4.3. Treatment System

The treatment system is designed to process two flow streams: (1) vapors and entrained liquids; and, (2) groundwater. The process flow diagram (PFD), piping and instrumentation diagrams (P&IDs), and construction drawings are presented in M-1 through M-8 (Appendix D). The treatment system presented here may change if required to meet operational requirements.

A high-capacity, high-vacuum blower will be used to extract volatilized vapors and steam from the MPE wells. The extracted vapors will be piped back to the treatment system via a common header and will first pass a silt knockout tank to separate silt from the fluid stream.[5] The fluid stream will then pass through two heat exchanger to reduce temperature and a liquid-vapor separator to extract entrained liquids and additional condensate formed due to cooling in the heat exchangers. Following liquid removal, vapors will be drawn through the vacuum blower and will pass through another heat exchanger to reduce the vapor temperature and a second liquid-vapor separator to extract remaining condensate. Vapors will then be an acceptable temperature for efficient treatment using a regenerative granular activated carbon (GAC) system and sacrificial activated carbon prior to discharge to atmosphere.

Extracted groundwater from the liquid and MPE wells along with condensate collected in the knockout tanks will be pumped into a liquid phase separator vessel. Accumulated DNAPL will be periodically gravity-drained into storage tanks for offsite disposal. The liquid phase separator vessel is designed to handle LNAPL, but no LNAPL is expected in the liquid stream.

Water from the phase separator will be gravity fed to an air stripper which is vented to atmosphere. Per Indiana Department of Environmental Protection (IDEM), an air discharge permit is not required for total VOC emissions of less than 10 tons per

[5] Silt is settled out in the KO-90, which is large capacity (4500 gallons) allowing for natural settling. Finer silt can migrate to the oil/water separator holding tanks, bag filter system, and potentially liquid GAC tanks. Silt is removed from the KO-90 tank with a vacuum truck at the end of the project. Other components are manually cleaned, and this is performed via back wash system for the liquid GAC if necessary.

year[6]. There are no daily atmospheric loading limits that could be exceeded. However, air discharge to atmosphere will be monitored daily as described in the SAP (Mc² 2017B).

Liquid effluent from the air stripper will be pumped into a holding tank, a bag filter, and liquid-phase granular activated carbon (LGAC) units before storage in a holding tank. Treated water will be used for ET-DSP™ recirculation, or discharge under the applicable requirements. The liquid discharge will meet IDEM requirements under the National Pollutant Discharge Elimination System (NPDES). Discharge requirements are listed in Appendix A of the SAP (Mc², 2017).

As the above ground treatment system includes components to treat and store hazardous wastes prior to disposal, the system will be constructed with secondary containment. This includes all treatment components that may contain unprocessed fluids, and storage vessels for untreated liquids and extracted DNAPL. All secondary containment will have high-level sensors in the sumps to shut down the system if a leak is detected. Additionally, all transfer hoses with unprocessed liquids will be double contained. Refer to Section 4.3.10.

Groundwater sample analysis indicates iron content ranges from 0.2 to 102 mg/L in the treatment volume. Elevated water hardness was also measured, ranging from 231 to 1,050 mg/L calcium and 76 to 410 mg/L magnesium (Appendix A).

Given the high levels of iron detected in the groundwater samples, an iron-sequestering system will be required for the treatment system. A sequestering agent

[6] Refer to Appendix A of SAP (Mc² 2017). An air permit is not required under CERCLA but substantial requirements for Indiana Permit must be met. Vapor carbon treatment will be installed and available for use since the mass estimate of 20,000 lbs may result in excess of the 10 ton per year VOC emissions per IDEM requirements.

Indiana has a state best available control technology (BACT) requirement for new sources with a volatile organic compound (VOC) potential to emit (PTE) of 25 tons per year (tpy) or greater (326 IAC 8-1-6). If the VOC PTE of the source exceeds the applicability threshold, Indiana would require a case-by-case review to determine what constitutes BACT (i.e. what controls are needed). Carbon treatment is one form of controls. The total VOC mass estimated for the DNAPL Area and ATT Area is approximately 10 tons. As further discussed below, the total mass of VOC in the treatment area provides a conservative estimate of the PTE. Therefore, the PTE for the ERH is likely less than the 25 tpy threshold and the state-level BACT requirement would not apply.

The Site Remediation maximum achievable control technology (MACT) standard (40 CFR 63 Subpart GGGGG) applies to major sources of hazardous air pollutants (HAP) that are >10 tpy for individual HAP or >25 tpy for total HAP. As the PTE for total VOC is likely around 10 tons, the PTE for the individual HAPs would likely each be less than the 10 tpy threshold, and the PTE for total HAP would likely be less than the 25 tpy threshold. Therefore, the Site Remediation MACT standard would likely not apply. USEPA recently published proposed changes to this standard that would, among other things, remove the exemption for site remediation activities conducted under the authority of CERCLA as a remedial action or a non-time critical removal action. The comment period on the proposed rule closed on July 27, 2016. Based on the proposed rule, it appears that even if the exemption for CERCLA corrective actions were to be removed from the rule, the rule would continue to apply only to major sources of HAPs.

Finally, there are no atmospheric loading limits specific to Boone County, IN that could be exceeded.

will be injected into the groundwater recovery line to prevent iron precipitation and fouling in the groundwater treatment system, thereby maintaining contaminant removal efficiency and proper system operation.

Similarly, elevated calcium and magnesium hardness indicates likely scale deposit issues, and a calcium/magnesium sequestering agent will also be injected into the groundwater recovery stream. This sequestering agent would prevent carbonates from precipitating, helping to effectively control scaling.

The recommended sequestering agent to prevent both iron and hardness scaling at the site is Analytix Technologies AN310-FG. The Safety Data Sheet (SDS) is provided in Appendix F – Safety Data Sheets.

3.4.4. VOC Releases and Removal Efficiency

It is estimated that 90% to 95% of the mass removed from the subsurface will be in the vapor stream and will be treated using the regenerative GAC unit. Removal efficiency from the vapor stream is expected to be greater than 95%.

The groundwater and vapor condensate streams will be treated with a liquid phase separator and an air stripper. Most of the dissolved contamination will be removed by the air stripper; however, a LGAC system will be used as a polishing stage. The removal efficiency for this process is expected to be greater than 95%. The percentage of mass that will be removed as dissolved contamination is expected to be less than 10% of the total mass.

All tanks containing VOCs or untreated water will be held under vacuum to control fugitive emissions. A line from the knockout tank will be connected to all treatment tanks through a vacuum regulator and vacuum relief valve, to prevent any VOC vapors from escaping. All tanks will also have individual vacuum relief valves as a safety precaution. Additionally, all valves, flanges, and pipe joints shall be monitored periodically via use of a handheld Photoionization Detector (PID) during routine inspections to monitor for fugitive VOC emissions.

3.4.5. Vapor Granular Activated Carbon Regeneration

An on-site electric-steam system will be used to regenerate the two-bed carbon system in the vapor treatment design. The electric steam boiler will steam clean one of the carbon beds as the other is being loaded. The clean carbon bed will then stay off-line, in parallel until needed.

When the carbon bed that is being loaded becomes saturated with solvent, the contaminant-laden vapor is routed to the second adsorber, while the saturated adsorber is taken off line to be regenerated. The time between regenerations varies depending on the concentration of the influent air. Regeneration can be triggered at a specific time interval, or as breakthrough is observed (concentration spikes are noted with a PID), and is expected to be required approximately every second day during the initial heating phase of the project (first 55 days) and approximately every day during the maintenance mode (last 125 days).

Regeneration consists of three steps: steaming, purging, and drying and cooling. Each is described in turn below.

1. **Steaming**: During steaming, steam is allowed to enter the adsorber, flowing from the bottom of the adsorber, counter current to the original vapor flow, to the top, heating the carbon and desorbing the solvents from it. The steam is used to heat up the carbon and the solvent. The flowing steam and heat strip the solvents from the carbon bed. Once the carbon has been heated a steam and solvent vapor mixture flows from the adsorber via the distillate valve through the distillate duct to the water-cooled condenser/cooler, where it condenses to a liquid solvent/water mixture, and is cooled. The steam and solvent are cooled to approximately 90°F, condensing into water and NAPL. The fluid then flows via gravity to the NAPL separator where the NAPL is separated and flows to the NAPL storage tank. The water condensate flows to an upstream vapor-liquid separator where it gets removed and treated with the groundwater. After a period of time steaming ends and the adsorber proceeds into the purging/drying/cooling stages.

2. **Purging**: To purge the adsorber of hot, wet steam, atmospheric air is blown via the Cool Down/Purge Blower, into the lower portion of the adsorber for several minutes. The displaced steam flows through the condenser, as during the steaming cycle. The control panel then cycles to the Drying and Cooling stage.

3. **Drying and Cooling**: The Purging air is shut off and atmospheric air is then blown to the upper part of the adsorber. As cool atmospheric air passes down through the adsorber it dries and cools the carbon. The air is exhausted from the adsorber via the exhaust valve, to the atmosphere. The Drying and Cooling cycle continues for a minimum of one hour and can run for several hours, depending upon Site conditions. Generally, longer is better, as all traces of moisture are removed. Now the adsorber is idle waiting to go back on adsorb once the other adsorber finishes its adsorption cycle.

The time required to complete a regeneration cycle varies predominantly as a function of the humidity of the ambient air. When the ambient air is humid, the drying and cooling cycle takes longer. A conservative estimate for the length of the cycle is 7 hours.

3.4.6. Injection System

Water will be injected at each electrode to enhance convective heat transfer within the treatment volume, mitigate the dipole effect, and maintain liquid contact at each electrode surface to avoid breaking the electrical circuit. Each electrode will be equipped with both top and bottom water injection lines, which will deliver water from the WCS units to the subsurface through laser-cut injection slots. The shallow electrode in each borehole will be equipped with a water return line – which has a spring check valve to prevent back flow – to prevent overpressure conditions as needed. The average total injection rate for all electrode locations will be 7.7 gpm (average of 0.1 gpm per electrode), and is expected to be variable during operations. Water that has been extracted and treated will be used to supply the WCS units and ET-DSP™ electrodes. The treatment system will be configured to maintain temperature of the treated water of at least 55ºC for reinjection to the electrodes (once sufficient temperature is achieved in the treatment volume).

3.4.7. Utility Requirements

3.4.7.1. Electrical

Results from the Thermal Model indicate that the cumulative energy input to the 77 electrodes over 180 days of operation will be approximately 1,837 MWh. The power requirement will be satisfied by a three-phase 1,500 kVA (Kilo-Volt-Ampere) service. A transformer with a 480/277 V Wye secondary will be serviced from a new power pole located at least 25 ft from the nearest electrode. Note that earth-grounding of electrical equipment, including the transformer and power distribution panel (PDP), is to be located at least 25 ft. from the nearest electrode. Electrical equipment is to be isolated from the electrodes by this distance or isolated with wood dunnage or other means. A detailed description of the electrical requirements is presented in the single line electrical drawing ESL-01 (Appendix C).

3.4.7.2. Water Usage

An average water usage rate of 7.7 gpm for the electrodes is anticipated over the 180 days of system operations resulting in a total water requirement of approximately 2 million gallons of water. Water will be extracted at a rate of 8.0 gpm, totaling a cumulative extraction of 2.07 million gallons, and resulting in approximately 78,000 gallons of treated water being discharged as effluent. Additional discharges are associated with various pieces of treatment equipment as described below. These estimates will be modified and controlled during operations based on subsurface behavior. The Thermal Model will confirm water injection, treatment and discharge requirements.

Discharge flows from treatment equipment include blow down water from cooling towers, boilers, and treated discharge from steam regeneration of GAC units. These sources' combined discharge is expected to range from 3-8 gpm. Process water flow for discharge will be regulated by first transferring to an equalization tank (T-207 shown on PFD M-1 in Appendix D). The sizing of this tank may change depending on discharge requirements and subsurface conditions. Water will be discharged following substantial requirements of NPDES and IDEM.

Treated water will be used for injection to the electrodes, but a back-up water supply must be available. Approximately 5,000 gallons of water will be used for treatment system wet testing during startup. A booster pump at the treated water holding tank will supply the WCS units with injection water. System water may be provided from Finley Creek if sample analysis performed by Mc² indicates the water is acceptable for this purpose, i.e. does not introduce contaminants into the treatment system or electrode injection water. Otherwise system water will be supplied from a holding tank with water delivery arranged with a local vendor.

Treatment system water consumption is dynamic throughout the project life cycle and is the sum of the cooling tower, boiler, and electric steam generator demand. The cumulative water supply requirement is approximately 1.45 million gallons during 180 days of operation.

The cooling tower will have a constant blow down throughout the project of approximately 1 gpm. The maximum rate of water lost through evaporative cooling is approximately 2 gpm, but depends on the ambient temperature, the humidity, and the amount of energy being dissipated. Total treatment system demand for these elements is approximately 5 gpm.

The electric steam generator will consume water for regenerative GAC at an approximate total rate of 4 gpm during the steaming cycle (Section 3.4.5), which is expected to last for approximately 4.5 hours and will be occurring approximately once every two days during the heating phase of the project (first 55 days) and then approximately once per day during the maintenance phase (next 125 days).

3.4.8. Telecommunications

The telecommunications system that will be used includes a LAN at the Site for real-time data communications. A high-speed Internet connection for offsite data transfer and remote control of the system by Mc² will be installed. Minimum 300 kbps download and upload speeds are required. Onsite personnel will require cell phones to communicate with Mc² project staff.

3.5. Controls & System Monitoring

Monitoring of the treatment system is accomplished through automated and manual system checks. The treatment system will be equipped with liquid level sensors to activate pumps and trigger alarms in the event of high and low liquid level conditions. The discharge holding tank will have a high-high level sensor to shut down the system to prevent an overflow of the tank. The liquid phase separator will also have a high-high level sensor that will shut down the system to prevent an overflow. The knockout tanks will have high-high, high, low, and low-low level switches to control and protect the transfer pumps and prevent an overflow of the oil/water separator.

In the event of a treatment system shutdown, operations personnel will be alerted via automated call-out, email, or text message to their cell phones.

3.6. Contingency Measures

In the event of resistive conditions in the subsurface, a potassium chloride (KCl) solution may be injected via the WCS units. This will increase the electrical conductivity of the subsurface (in accordance with Archie's Law), which in turn increases the power density of electrical resistance heating dissipated in the subsurface (e.g., McGee and Vermeulen, 2007). This technique can be used to bring electrode power levels up to typical values; however, it is counter-productive to over-inject KCl, as this could decrease the conductivity to the point that the soil is too conductive to be easily heated. If injected, KCl concentrations must be below water quality standards and/or local environmental protection levels.

Based on the electrical profiling results and increased heating energy required in the ATT Area, KCl injection will be required at the lower ports of the ATT electrodes. The maximum KCl concentration to be injected to the ATT electrodes will be 175 mg/L. During the temperature ramp-up phase of operations, it is anticipated that a maximum of 200 L of KCl solution will be injected twice per day until all ATT electrodes are maintained above 5 kW. KCl injection is not anticipated in the DNAPL Area. The SDS for KCl is included in Appendix F – Safety Data Sheets.

3.7. Sampling and Analysis

Vapor samples will be assessed at the blower outlet and between each vapor GAC unit and screened using a PID. In addition, vapor samples will be collected at specific locations along the treatment train at periodic intervals for laboratory analysis. The PID measurements will be calibrated to the analytical vapor measurements and both data sets will be used for the quantification of mass removal, carbon bed mass loading and mass discharge to atmosphere.

Liquid samples will be collected at the inlet of the air stripper and between each liquid GAC unit for laboratory analysis. These samples will be taken at periodic intervals. Effluent concentrations will be used for the quantification of mass removal, carbon bed mass loading, and mass discharge to sewer.

The sampling procedures and safety precautions are outlined in the SAP and HASP. Ramboll Environ will be responsible for conducting compliance groundwater sampling of the treatment area at the end of operations and after sufficient cooling of the treatment volume. Additional sampling will be required if operations are extended.

No groundwater sampling is proposed prior to ERH treatment, as the baseline has been established for the remedial goal of a 90% reduction in the concentration of contaminants of concern in groundwater, and the remedial goals are not related to soil concentrations. For sampling results that establish the remedial goals in the DNAPL Area, refer to Tables 1 and 2 of Memorandum dated Feb 19, 2008, "In Situ Chemical Oxidation Confirmatory Ground Water Sampling - DNAPL Containment Area" (Environ 2008A). For comparison to more recent groundwater sampling results in the DNAPL Area, refer to Table 4 of "Monthly Progress Report – June 2013" (Environ 2013B). For the ATT Area, refer to Table 2 of Ramboll April 2017 Monthly Progress Report (Ramboll 2017) for baseline total VOC groundwater concentration in monitoring well MW-27R.

Several other processes and well field parameters will be monitored during system operations. A summary of the data collected and the frequency of that collection is presented in Table 8. Mc^2 may adjust the schedule to perform the manual reading as the project progresses if reasonable within the interests of the project.

Monitoring, sampling, and analysis data will be used to characterize performance of the ERH and treatment system, identify potential system optimizations, and evaluate conditions for shutdown of treatment operations prior to confirmatory groundwater sampling events.

Various measurements will be used to determine shutdown of thermal treatment as described in the SAP (Mc^2, 2017). If PID VOC readings at the extraction wells decrease to residual levels and reach asymptotic conditions, this will provide an indication that the 90% contaminant reduction objective in groundwater has been achieved. The extraction well PID readings may not correspond with contract action levels and PID concentrations less than the groundwater action level of 4,285 µg/L will not alone determine shutdown of ERH operations. Sampling and analysis in the treatment system will be used to calculate mass recovery in the vapor, liquid and NAPL phases relative to the mass estimate of 20,000 lbs, and also will be used to evaluate asymptotic mass recovery conditions, providing additional indications when ERH shutdown may occur. The final decision for shutdown of ERH operations will rely on expertise of the Mc^2 project team in consultation with TSTF and EPA.

Table 9: Monitoring Summary

Item	Media	Location	Method	Frequency
Power, current, voltage	Subsurface	Electrodes	PDS (automatic)	Minutely (averaged daily)
Temperature	Subsurface	Sensor wells	digiTAM™ (automatic)	Hourly (averaged daily)
Temperature	Extracted fluids	Extraction wells, treatment system	Temperature gauge or gun (manual)	Daily
Vacuum	Vapor extracted	Vacuum Monitoring / Extraction Wells	Vacuum gauge (manual)	Daily
Flow Rate	Vapor extracted	Treatment influent	Averaging pitot tube (manual)	Daily
Flow Rate	Vapor discharged	Treatment effluent	Averaging pitot tube (manual)	Daily
Flow Rate	Vapor extracted	Extraction wells	Averaging pitot tube (manual)	Biweekly
Volume	Water extracted	Treatment influent	Flow totalizer (manual)	Daily
Volume	Water discharged	Treatment effluent	Flow totalizer (manual)	Daily
Volume	Water injected	Treatment reinjection	Flow totalizer (manual)	Daily
Volume	Water injected	Electrodes	WCS (automatic)	Hourly (averaged daily)
Vapor VOCs	Vapor extracted	Extraction wells	PID (manual)	Biweekly
Vapor VOCs	Vapors treated	Treatment system	PID (manual)	Daily
Vapor VOCs (Analytical)	Vapor discharged	Treatment effluent	Tedlar bag	Biweekly
Liquid VOCs[1] (Analytical)	Liquids treated	Treatment system	USEPA 624 Pump or valve (manual)	Biweekly

[1]And other analytes required for discharge compliance

4. Construction Activities

Field construction will include the installation and/or performance of:

- ET-DSP™ electrodes;
- MPE wells;
- DigiTAM™ sensor and vacuum monitoring wells;
- Treatment system piping and hoses;
- Electrode lead wire, hose, and communication cable;
- Connection of the treatment system equipment;
- Power connections to the PDS and WCS equipment;
- Power connections to the ET-DSP™ and treatment equipment;
- System acceptance testing; and
- Wet testing the treatment system prior to startup.

Mc² and MK Environmental personnel will perform these construction activities and Mc² will provide both construction oversight and construction management services. Subsurface construction including installation of electrodes, MPE wells, and sensor wells will be performed by the drilling subcontractor under direction of Mc². The drilling services company must be equipped to use sonic drilling methods, handle all drilling wastes, and meet the HASP requirements for the Site.

4.1. Staging Equipment & Supplies

All equipment and supplies used during the construction of the treatment system will be staged in a secure manner. The PDS and treatment systems will be located within the secured area. The lifting details for the ET-DSP™ equipment can be found in the Site Management Plan (Mc² 2017).

The approximate layout of the treatment system, PDS units, and WCS units are presented in the wellfield layout (WFL-02, Appendix C). A more detailed version showing the proposed treatment equipment locations is provided in Drawing M-9 (Appendix D). The most efficient placement of the PDS and WCS units, such that hose and wire runs are minimized, will be confirmed during equipment off-loading. Mc² equipment cut sheets are presented in Appendix E.

4.2. Subsurface Construction

4.2.1. Drilling Program

The preferred drilling method for subsurface installation of the electrode, extraction well and sensor well components is sonic drilling, which provides excellent production, accurate installation, and has proven results for large electrode networks on other thermal projects. The proposed drilling program is detailed in Table 10. All drilling and construction waste will be appropriately containerized for onsite storage prior to offsite disposal. Handling of Investigation Derived Waste (IDW) will be performed by the drilling subcontractor under the direction of Mc². The disposal facility has not been selected but the wastes will be characterized per the disposal facility permit and applicable regulations. Refer to the SMP (Mc², 2017) for details of waste management.

No soil sampling is proposed during the drilling program, as the baseline concentrations have been established for the remedial goal of 90% mass reduction of VOCs in groundwater, and the remedial goals are not derived from soil concentrations. Refer to Section 3.7.

Table 10: Drilling Program Details

Item	Qty	Depth (ft)	Boring Diameter (in)	Total Depth (ft)	Drilling Waste (yd^3)	Notes
Electrode Boreholes	23 10	43.3 18.5	12 12	952.6 203.5	28.9 5.4	10" diameter casing ID required for electrode installation.
MPE Boreholes	18 6	41.5 18.5	8 8	729.0 108	2.4 0.3	Approximately 2,727 gallons (5 well volumes/well) of water will be produced during well development; water table at ~10 ft BGS
digiTAM™ Boreholes	9 2	40.5 17.5	4 4	364.5 35.0	1.2 0.1	To accommodate 1" carbon steel riser pipe
Vacuum Monitoring Boreholes	1	8.5	4	8.5	0.0	Screened stainless casing installed to depth of vadose zone.
Total		N/A	N/A	2,401.1	38.3	

4.2.2. Underground Utilities

The Site has no known utilities running through the thermal treatment volume. A one-call utility markout and private locate will be performed prior to drilling and construction.

4.2.3. Electrode Wells

Electrode boreholes will be approximately 12 inches in diameter and drilled using sonic methods. Three ET-DSP™ electrodes will be installed into each borehole at 23 locations in the DNAPL Area, and one electrode will be installed in each borehole at ten locations in the ATT Area. The electrodes are 10 ft long (12 ft in ATT) by 8 inches in diameter and weigh approximately 100 lbs. The bottom of the electrodes will be installed at approximately 42 ft 8 in BGS in the DNAPL Area, and 18 ft BGS in the ATT Area. The boring depth will extend 6 inches below the electrodes and sand will be used to backfill the annulus of each electrode. Backfill around the upper DNAPL Area and ATT electrodes will use a 1:3 ratio of granular graphite to sand, and this ratio will be 1:7 around the lower and middle DNAPL Area electrodes. The backfill between the electrodes will consist of a 10/20 silica sand up to a boring plug, which will consist of a fine sand seal (35/70 silica sand or equivalent) and neat cement grout, able to withstand elevated temperatures, finished to ground surface (Portland Type I/II or equivalent). Additional electrode construction details are presented in drawings WCD-01 and WCD-02 (Appendix C).

The electrodes are manufactured with silicone rubber glass fiber tube (SRGT) lead cable. All electrode cables will run from the PDS units to the electrode borehole locations under the piping network. The electrodes will each be equipped with a top and bottom water injection hose. These hoses will be connected through a tee fitting at the surface to a 3/8-inch general-purpose water conveyance hose. A water return line will be included from each vadose electrode to alleviate potential pressure build up in the well during operation.

4.2.4. Extraction Wells

The MPE well boreholes will be 8 inches in diameter and drilled using sonic methods. These wells will consist of 4-inch diameter continuous wire wrap 0.010 inch slotted 304L stainless steel screen. The screened interval will be from 3 to 40 ft BGS in the DNAPL area, and 6 to 18 ft BGS in the ATT area. A 20/30 silica sand filter pack will be installed in the annular space around the well screen. The boring will be finished to ground surface with 2 ft of neat cement grout above a 0.5 ft fine sand seal (40/60 silica sand or equivalent). A 1 ft. sump will be installed below the screen of each extraction well. The top of the carbon steel riser pipe will be completed with a 4-inch male National Pipe Thread (NPT) fitting. Each extraction well will be completed with a wellhead, which in turn will be connected to a pipe network for conveyance to the treatment system. MPE well designs are detailed in drawings WCD-01 and WCD-02 (Appendix C).

The MPE wells will each be equipped with a 1 inch outside diameter (OD) crossed-link polyethylene (PEX) downhole compressed air-assisted vacuum groundwater recovery tubes (i.e., slurper tube).[7] The compressed air line will be a ¼ inch OD polytetrafluoroethene (PTFE) tube internal to the PEX tube. A main vacuum blower will apply vacuum to the wellhead in the aboveground treatment system. Each wellhead will be equipped with a temperature gauge, a vacuum gauge, and a sample port/bleeder valve. Detailed wellhead and slurper tube design drawings are presented in drawing WHD-01 (Appendix C).

4.2.5. Sensor/Monitoring Wells

Installation of digiTAM™ sensors will be performed in conjunction with the installation of the electrodes and extraction wells. The temperature sensor (digiTAM™ string) is a 0.5-inch diameter tube or hose, with digital sensors embedded at approximately 3

[7] The PEX tubing used on the extraction lines has a softening point of 121°C and has proven compatible with extracted liquid temperatures produced during ERH operations.

ft depth intervals, that will be housed in a watertight 1-inch carbon steel casing with coated NPT threads for a water tight seal. Grout will be used to fill the annular space around the carbon steel casing to surface. Sensor well construction drawings are presented in drawings WCD-01 and WCD-02 (Appendix C). Sensor wellhead details are presented in drawing WHD-01 (Appendix C).

One (1) perimeter vacuum monitoring well will be installed between the ATT Area and Bankert Pond (within the MPE equipment pad area). A 1-inch screened stainless steel casing will be installed to the depth of the vadose zone at the location (approximately 8.5 ft BGS based on the depth of water table). A 20/30 silica sand filter pack will be installed in the annular space around the well screen. The boring will be finished to ground surface with 2 ft of neat cement grout above a 0.5 ft fine sand seal (40/60 silica sand or equivalent).

The Cat5 communication cable for each digiTAM™ unit will be connected to the sensor string through a junction box and brought back to a remote box located in the well field. Up to 24 digiTAM™ units can be connected to each remote box.

4.2.6. Piping Systems

Above surface extraction system piping will be installed and connected to the extraction wellheads. One pipe network for the extracted vapor/liquid streams and one pipe network for the compressed air supply will connect the well field and the treatment system area. Each of these pipe networks will be thermally and electrically isolated as a safety precaution during operation.

The main multiphase extraction vapor/liquid header into the treatment system will be an 8-inch diameter schedule 40 carbon steel pipe. All extraction pipes will be sloped at an approximate 1° angle towards the treatment system for gravity drainage. The extraction header piping will rest on wooden supports for electrical isolation, and electrical cables and hoses will run underneath these supports. In addition, a 1-inch carbon steel pipe will run underneath these supports to supply compressed air to the slurper tube assemblies.

The MPE wellheads will each have three lateral connections to the treatment area headers:
(i) 2 inch OD high temperature vacuum hose for the vapor stream,
(ii) 5/8 or 1 inch OD PEX tube for the recovered groundwater stream, and
(iii) 1/4 inch OD PFTE tube for the compressed air stream.

Each connection point to the vapor/liquid extraction headers will have a 1-inch valve to adjust the vapor flow rate and a 5/8 or 1-inch valve to adjust the recovered groundwater flow rate. Each connection point to the compressed air headers will have a 3/8-inch valve to adjust the flow rate. All manifolds on the lateral piping will be complete with cam and groove fittings to facilitate maintenance and breakdown of the piping network. A wooden support is also required under the Kynar® isolation nipple at each wellhead.

Due to the likelihood of mineral scaling due to the water hardness combined with elevated temperatures, 2 spare PEX lines will be run from each well head to the treatment system. In the event of constriction due to scaling inside the liquid PEX line from any well, the operator can disconnect the line from the wellhead and connect it to a spare, creating a loop. The operator would then circulate a dilute acid mixture through the connected lines, which will dissolve most precipitates and clean out the line. The spare line may be used for the extraction flow stream if the first line cannot be cleaned out.

4.3. Above Ground Construction

4.3.7. Aboveground Utilities

No existing overhead utility lines are expected to impact site activities within the thermal treatment zone. However, an existing overhead line is located above the site access gate. A new overhead line will be installed to supply power to the utility transformer for the full-scale ET-DSP™ system. During entry to the Site, care will be taken for drilling rigs, cranes, and similar equipment to remain at least 10 ft from any overhead lines, or as specified by the local jurisdiction.

4.3.8. Power Supply

A detailed description of all power supply connections, cable runs, and specifications can be found in the electrical single line diagram (ESL-01, Appendix C). Mc² will coordinate with a local, licensed electrical contractor to perform the appropriate electrical connections upstream of the ET-DSP™ electrodes.

4.3.9. ET-DSP™ Neutral Connections

All extraction wells will be fitted with electrical lugs on the bottom flange plate of the wellhead where a 1/0 bonding wire will be attached. Bonding wires from up to eight extraction wells will be connected together in a daisy chain using split bolts and a single wire will be brought back to the PDS unit to connect to the ET-DSP™ neutral. The groups of extraction wells that will be connected will coincide with the groups electrodes that are connected to each PDS unit, such that specific areas can be isolated while other areas continue to operate.

Aboveground structures such as treatment system units and PDS units will be grounded using grounding wire. This network will be connected to the utility ground and will be brought back to the transformer where the utility is connected. The WCS is bonded to the associated PDS unit using a 2/0 grounding wire. All equipment in or near the well field will be placed on wood or concrete blocks or otherwise isolated. The ET-DSP™ neutral is separate from the utility ground, which creates a return path for the input energy back to the energy source to control power delivery.

4.3.10. Treatment System

Placement of the treatment equipment is not yet determined. It is suggested the treatment equipment be placed in the clear area adjacent and east of the treatment area. 6 inches of #57 stone will be put in place and compacted with three passes of heavy equipment by Mc² to provide a working surface for placement of the treatment equipment.

The liquid treatment system equipment will be skid-mounted with secondary containment in the skid. This secondary containment will have a high-level sensor in the holding tank to shut down the system if a leak is detected. Additionally, all transfer hoses with unprocessed liquids will be double contained (primary with sleeve).

Once the treatment system is staged at its designated location, a short section pipe will be installed from the completion of the extraction system header to the primary liquid/vapor separator. The treatment system equipment will arrive with the controls described earlier pre-installed. After completing all piping connections, the MPE collection system piping will be pressure tested at 60 PSIG for 30 minutes. To ensure the piping system is leak-proof, the pressure will be maintained at 57 PSIG or above over the duration of the test. If any leaks occur Mc2 will replace piping or repair connections and retest the piping until all connections are leak-proof.

5. Operational Strategy

5.1. Operations and Maintenance

The operational schedule for the anticipated stages of initial heating, maintaining target temperatures, pressure cycling and cool down is described in the Site Monitoring Plan (Mc² 2017). This document also contains details regarding startup, operations, and maintenance procedures. The HASP describes the health and safety requirements for ERH operations.

5.2. Hydraulic and Pneumatic Control

Controlling potential migration and/or redistribution of COCs will be achieved by maintaining a sufficient vacuum and hydraulic control within the treatment volume. Hydraulic and pneumatic control will be established through the extraction of subsurface fluids at sufficient rates, and monitored throughout the ET-DSP™ application with vacuum pressure gauges and flow totalizers. A ratio of extracted liquids to injected water must be unity or greater to maintain hydraulic control.

Groundwater table elevations will be measured at the extraction wells using a level interface probe, while the electrodes are turned off, to ensure that inward hydraulic gradients are maintained throughout the treatment volume. Groundwater elevation and vapor vacuum level measurements will be made at existing extraction well EW-3 and at the new perimeter vacuum monitoring well VM-E1 to provide a basis of comparison to conditions inside the heated volume.

5.3. Power and Pressure Cycling

Once the target zone is heated to maximum temperatures and mass recovery begins to go asymptotic, temporal pressure changes will be induced in the target formation by varying power and water circulation to individual electrodes and the vacuum applied to individual wells. By increasing electrode power and water injection to selected electrodes and decreasing extraction vacuum at selected extraction wells, subsurface pressures (and thus temperatures) can temporarily be increased in these areas, to be followed by a rapid increase in vacuum to vaporize remaining residual contamination. Areas adjacent to the target areas may be put in low-power, low-vacuum modes in order allow higher power and vacuum in target areas. This non-uniform application of pressure-cycling has two desirable effects: maximizing vaporization of any residual contamination, and creating new flow paths and gradients through areas that previously experienced flow stagnation. The areas targeted by this process can be rotated until the entire treatment volume has been so treated.

5.4. Health & Safety

Safety is of paramount concern during all phases of this remediation project. The site-specific HASP (Mc² 2017) includes provisions for the strict adherence of safety standards and controls during drilling, construction, and operations. This will ensure that the potential for exposure of personnel to hazards and unsafe conditions is minimized.

Due to potential chemical and thermal hazards, Bankert Pond will not be accessible to the public during treatment operations. Fencing will be extended around the pond during construction phase and remain in place for the duration of the project. Existing fencing around Third Site perimeter will not be modified. Refer to Drawing SMP-04 of the SMP (Mc² 2017) for layout of new fencing to enclose Bankert Pond. Fencing will be 8 ft high chain-link and green in color to match existing fencing at Site. Fencing is not to be placed along the pond shoreline in contact with the sheet pile and will be physically isolated from the ERH treatment areas by a minimum distance of 10 ft. Supply and installation of new fencing will be contracted to a local vendor.

An interior infrared fence will be installed that will shut down the ET-DSP™ system if crossed during hours when personnel are not on site. The interior infrared security system is intended to provide a redundant safety measure for system shutdown in the event of entry by unauthorized personnel. When tripped, a call will be placed to the Site operator. The infrared fence will enclose Bankert Pond (internal to the chain-link fencing) and the ERH treatment areas.

One pan-tilt-zoom camera will be mounted on a pole at a PDS unit. This will be placed to provide view of Bankert Pond, ERH treatment areas and treatment equipment. The camera will be remotely accessible via a secure website. The camera will be configured with monitoring software to continually pan the Site and provide motion capture within the controlled access area. The motion capture feature will not be interlocked shut down the ET-DSP™ system, due to potential false alarms due to wildlife or high winds. However, the Site operator will be notified of motion detection events, and will login to view the camera directly and take appropriate action if an unauthorized person has accessed the site. The camera also provides a means to investigate remotely if the infrared fence is tripped.

Appropriate signage will be placed throughout the Site and on the perimeter fence. The perimeter fence signage will provide warning of high voltage hazards and indicate access for authorized personnel only, in particular on the new fencing around Bankert Pond. High voltage zones, hot surfaces and process tanks will be appropriately labeled and placarded.

5.5. System Decontamination Procedures

Mc² and MK have developed extensive equipment decontamination procedures. The system will be subject to a steam cleaning procedure starting at the extraction wellheads while the treatment system is operating and generating vacuum. All contaminated vapors and liquids generated by decontamination procedures are subsequently drawn through the treatment system. Steam decontamination is not suitable for WCS units, as they do not pipe back to the treatment system, and these units are decontaminated by circulating diluted hydrochloric acid (or muriatic acid) through them continuously for a minimum of 3 hours. Decontamination procedures specific to individual pieces of equipment are provided in the Site Management Plan (Mc² 2017).

6. Performance Monitoring

Performance monitoring will include extraction and treatment system parameters, ET-DSP™ parameters, pressure, and temperature. System monitoring, sampling, and analysis requirements and procedures are detailed further in the Site Monitoring Plan and the SAP (Mc^2 2017).

6.1. Subsurface Monitoring

Continuous monitoring of Site operations will be conducted to ensure that hydraulic and vapor capture are maintained, over-pressurization is prevented, and operational temperatures are achieved and maintained. Vapor vacuum gradients will be determined by manually measuring the vadose zone vacuum at extraction wells.

Temperature monitoring will be achieved with 132 digiTAM™ temperature sensors deployed in eleven (11) sensor wells located in the treatment area. These temperature data will be logged in a database and used to visualize subsurface conditions in thermal contour maps (e.g., Figure 2). These thermal maps are generated every day based on each digiTAM™'s average recorded temperature for the day before. Since the vadose zone will act as a saturated steam system under operating conditions, vacuum levels in this zone will be a function of temperature (and vice-versa).[8] This concept allows for interpretation of subsurface temperature data to provide supplementary subsurface vacuum estimates.

The vapor and liquid flow stream temperatures at the extraction wells will provide additional indication of subsurface heating performance. If temperature response is not adequate at an individual extraction well, Mc^2 will implement measures to improve heating performance in the area.

[8] Assuming saturated steam temperatures are achieved the measured temperature will correspond with the boiling temperature of water at the vacuum level according to published steam tables.

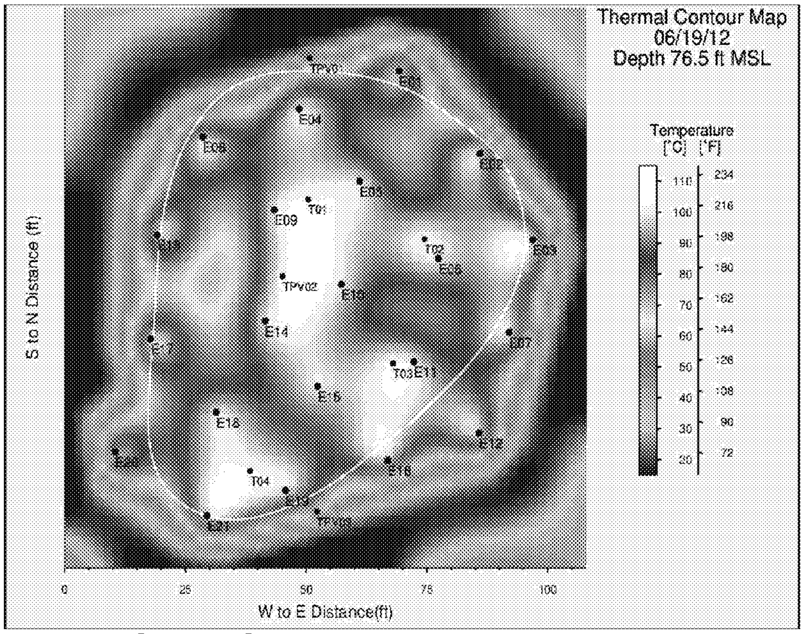

Figure 2: Sample Subsurface Temperature Distribution Map

6.2. Treatment System Monitoring

Onsite personnel will monitor the remediation system during operations. Site monitoring activities will be conducted at least once per day on weekdays, or at a reasonable frequency agreed upon by Mc² and the ET-DSP™ operator. Further details are described in the Monitoring Plan. Upon completion of each Site monitoring round, the information will be compiled into an ongoing project database available from the project website. Contaminant mass removed from soil, volume of liquid removed, system runtime, and subsurface vapor flow rates will be calculated manually using analytical results, PID, and flow measurements taken at periodic intervals.

6.3. Temperature and Vacuum Monitoring

Subsurface temperatures in the treatment volume will be monitored using the digiTAM™ wells, while vacuum levels will be monitored at the extraction wells. Vacuum data will be measured manually at EW-3, VM-E1, and each vapor extraction point and recorded on the project website.

The vapor and liquid flow stream temperatures at the extraction wells will provide additional indication of subsurface heating performance. If temperature response is not adequate at an individual extraction well, Mc² will implement measures to improve heating performance in the area.

6.4. Groundwater Sampling

Once asymptotic conditions are reached and the project team determines thermal treatment operations may cease, Ramboll Environ is responsible for confirmatory post-treatment groundwater sampling to assess COC concentration and mass reduction. The confirmation sampling locations are predetermined as described in Section 1.5.2.

The following wells will be replaced with stainless steel screen construction prior to ERH operations to allow monitoring of the remediation:

- Piezometer wells P-1, P-2, and P-3
- Monitoring well MW-27R.

The existing DNAPL Area Sump extraction well is constructed of stainless steel and will not be adversely affected by ERH operations. Refer to Section 4.2.1 of the SMP (Mc² 2017A) for locations of wells to be used for monitoring of the remediation.

6.5. Data Collection and Management

Mc²'s electronic data collection and management system will transmit data from addressed digital sensors located throughout the well field and treatment area via a communication protocol to an onsite server. The onsite server's database will function as the first storage location for the collected data and will also act as the conduit for real-time sensor data transfer to a central server located offsite for redundant storage. All data will be transferred between the onsite and central offsite servers over a secure Internet connection. The central server will be used to provide immediate access to relevant data, which in turn can used to calculate and render models of the thermal process and process real-time data for visual presentation. The database may be remotely accessed via the Internet.

6.6. ET-DSP™ Control Systems

The entire ET-DSP™ control system, including the WCS, will be connected to a LAN that, in turn, is accessible over the Internet and monitored via the project webpage. This will provide remote access and control for Mc² operators who may be offsite during operations.

ET-DSP™ also utilizes a TDC/IPS to control the power to individual electrodes via proprietary computer controllers within the PDS units. This method controls the sine wave of the three-phase power to the millisecond such that each phase can be individually manipulated, and can alter the phases of power applied to individual electrodes to re-orient the flow of electric current between electrodes. For example, should it become apparent that certain electrodes are in electrically resistive zones, the power to the electrodes in these areas can be increased with the TDC/IPS to encourage the development of a more uniform heating pattern. Additionally, the power delivery system includes an assortment of voltage tap settings to further control the heating process.

7. Summary and Conclusions

A combination of ET-DSP™ and MPE will be used to target the site for thermal remediation of the chlorinated VOCs present. Background information of the site and the remedial approach were presented. A summary of the 100% technical design was presented in Table 8, and includes:

- 77 electrodes at 33 locations;
- 24 MPE well locations;
- Eleven (11) digiTAM™ temperature monitoring locations;
- One (1) perimeter vacuum monitoring well;
- A vapor cap area of approximately 7,500 ft^2;
- Electrodes of 10 ft length (12 ft in ATT) by 8 in diameter;
- Electrode locations spaced at 18.0 ft, with ±1.5 ft of tolerance;
- Electrode well depths of 43 ft BGS in the DNAPL Area, and 18 ft BGS in the ATT area;
- Average and peak electrode power inputs of approximately 425 and 710 kW;
- A total energy input to the electrodes of 1,837 MWh;
- A target vapor extraction rate of 125 scfm;
- Total liquid injection and extraction rates of 7.7 and 8.0 gpm;
- A water injection requirement of approximately $2{\times}10^6$ gal; and,
- An approximate active heating time of 180 days.

A summary of the drilling program, construction details, operational strategy, and performance monitoring plan for the system and were presented, the latter of which includes:

- Electrode power, current, and voltage;
- Subsurface temperatures and pressures;
- Extraction well vacuum and temperature;
- Vacuum monitoring well vacuum levels;
- Water injection and extraction rate;
- Vapor extraction rate; and,
- Extracted, processed, and discharged VOC concentrations.

These data will be used to inform the operation of the system, and will be available on a secure project website for remote monitoring. Asymptotic conditions in the cumulative mass removal data will be used as a metric to assess ET-DSP™ shutdown, and post-treatment groundwater sampling will be used to confirm progress towards cleanup goals.

References

Bear, J., 1979. Hydraulics of Groundwater. McGraw-Hill, New York, New York, p. 368.

Chen, F., Freedman, D.L., Falta, R.W., Murdoch, L.C., 2012. Henry's law constants of chlorinated solvents at elevated temperatures. Chemosphere, 86(2), 156–165.

Haynes, W.M., Lide, D.R., Bruno, T.J., 2013. CRC Handbook of Chemistry and Physics 2013-2014, 94th ed. CRC Press, Taylor and Francis, Boca Raton, Florida.

McGee, B.C.W., Huang, H., Westbrook, R., Bohun, S., 2004. The Thermodynamic Bubble Problem and Its Relevance for In-situ Thermal Remediation. McMillan-McGee Corp.

McGee, B.C.W., Vermeulen, F.E., 2007. The mechanisms of electrical heating for the recovery of bitumen from oil sands. Journal of Canadian Petroleum Technology, 46(1), 28–34.

McGee, B.C.W., Donaldson, R.D., 2009. Heat Transfer Fundamentals for Electro-thermal Heating of Oil Reservoirs. In Proceedings of the Canadian International Petroleum Conference, June 16–18, Calgary, AB.

NIST, 2014. National Institute of Standards and Technology Chemistry WebBook. Website accessed on July 10 2014. http://webbook.nist.gov/chemistry/

Triplett Kingston, J.L., Johnson, P.C., Kueper, B.H., Mumford, K.G., 2014. In Situ Thermal Treatment of Chlorinated Solvent Source Zones, in: Kueper, B.H., Stroo, H.F., Vogel, C.M., Ward, C.H. (Eds.), Chlorinated Solvent Source Zone Remediation. Springer Science+Business Media, New York, NY.

USACE, 2009. Design: In Situ Thermal Remediation. EM 1110-1-4015. U.S. Army Corps of Engineers, Washington, DC.

USEPA, 2016A. Amended Administrative Order by Consent in the Matter of Third Site, Zionsville, Indiana. USEPA Region 5, Chicago, IL.

USEPA, 2016B. Amended Enforcement Action Memorandum, Request for Approval of a Change in Scope of Response Actions for the Non-Time Critical Removal Action at Zionsville Third Site. USEPA Region 5, Chicago, IL.

Environ, 2000. Third Site Field Investigation Data Report, January 2000. Environ International Corporation, Deerfield, IL.

Environ, 2003. Pre-design Data Report for Non-Time Critical Removal Action at Third Site, Zionsville, Indiana. Environ International Corporation, Deerfield, IL.

Environ, 2004. Design Report for Non-Time Critical Removal Action at Third Site. Environ International Corporation, Deerfield, IL.

Environ, 2008A. Memorandum. In Situ Chemical Oxidation Confirmatory Ground Water Sampling, DNAPL Containment Area, Third Site, Zionsville, Indiana. February 19, 2008.

Environ, 2008B. Memorandum. Proposed Confirmatory Ground Water Sampling, DNAPL Containment Area, Third Site, Zionsville, Indiana. December 31, 2008.

Environ, 2012. Vadose Soils Excavation Completion Report - Third Site Superfund Site. Environ International Corporation, Indianapolis, IN.

Environ, 2013A. Monthly Progress Report - April 2013, Third Site, Zionsville, Indiana. Environ International Corporation, Indianapolis, IN.

Environ, 2013B. Monthly Progress Report - June 2013, Third Site, Zionsville, Indiana. Environ International Corporation, Indianapolis, IN.

Environ, 2014. DNAPL Containment Area Supplemental Data Collection Report - Third Site Superfund Site. Environ International Corporation, Indianapolis, IN.

Ramboll, 2017. April 2017 Monthly Progress Report for Third Site. Ramboll Environ, Indianapolis, IN.

Mc², 2017. Site Management Plan for Third Site ERH.

Mc², 2017. Sampling and Analysis Plan for Third Site ERH.

Mc², 2017. Health and Safety Plan for Third Site ERH.

Mc², 2017. Monitoring Plan for Third Site ERH.

Appendix A – Resistivity Report

Kemron Resistivity Report

RAMBOLL ENVIRON

ENVIRONMENT
& HEALTH

TECHNICAL MEMORANDUM

Sent via Electronic Mail

To: Norman W. Bernstein – Trustee, N.W. Bernstein & Associates, LLC
Peter M. Racher – Trustee, Plews Shadley Racher & Braun LLP

From: Andrew Gremos, LPG, CHMM, Ramboll Environ US Corporation

cc: David Major, PhD – Savron Solutions
Ronald E. Hutchens – R.E. Hutchens Consulting

Subject: Soil Resistivity Testing, Hardness and Total Iron Sampling in Groundwater; DNAPL Containment Area, Third Site Superfund Site, Zionsville, Indiana.

Date April 5, 2016

Ramboll Environ
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Indianapolis, IN 46204
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On March 17 2016 Ramboll Environ and a drilling subcontractor installed two soil borings at at the Third Site Superfund Site in Zionsville, Indiana.; one within the DNAPL Containment Area, and one east adjacent of the DNAPL Containment Area,. The soil borings were advanced to collect samples for resistivity testing of the soil within the two areas where electrical resistance heating (ERH) treatment is planned. The soil samples were sent to Kemron Environmental Services in Atlanta, Georgia to be tested for soil resistivity, moisture content, and bulk unit weight. Figure1, located in Attachment 1, depicts the locations of the borings (SR-Boring 1 and SR- Boring 2).

The soil boring locations were centrally located within the interior of the two areas that are proposed to be thermally treated by ERH. SR-Boring 1 was centrally located within the DNAPL Containment Area between CMT-1 and the sump. SR-Boring 2 was located near MW-27R.

Prior to the drilling activities, underground utilities were located by Indiana Underground Plant Protection Service (IUPPS). On March 17, Ramboll Environ advanced two soil borings at the pre-selected locations; one within the DNAPL Containment Area, and one near MW-27R using direct push methods (i.e., Geoprobe®). Both borings were installed to a depth of 32-33 feet below ground surface (bgs). A direct push sampler, which consists of a 4-foot long by 1 or 2-inch diameter stainless steel corer, was hydraulically driven into the subsurface. For the soil boring within the

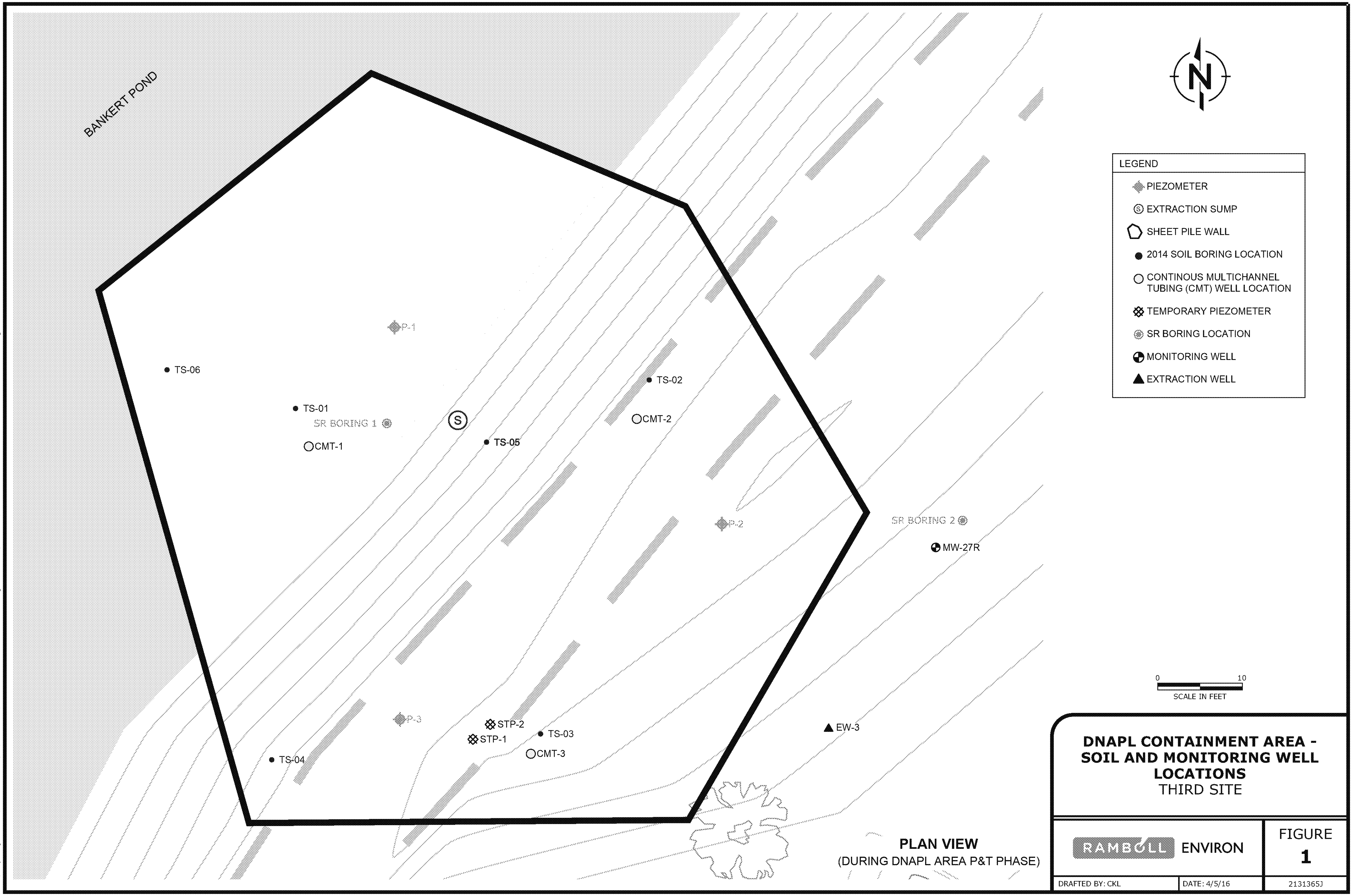
DNAPL Containment Area (SR-Boring 1), a 2-inch diameter steel corer was used for the sample collection method. Due to some difficulty at depth with the first soil boring, the drillers suggested using a 1-inch diameter steel corer, which used for SR-Boring 2. At both borings, four-foot long continuous soil samples were collected inside a polyacetate liner, and subsequently removed after retrieval of the sampler at the surface. The non-dedicated sampling equipment was decontaminated with a non-phosphate detergent and rinsed with deionized water. Soil screening samples at SR-Boring 2 were continuously logged for soil texture, and soil screening samples were collected continuously and field screened for volatile vapors using a photoionization detector (PID). Soil screening samples were not collected at SR-Boring 1 due to its close proximity to CMT-1/ TS-01. Boring logs for SB-Boring 1/CMT-1/TS-01 and SR-Boring 2 are provided in Attachment 2.

Soil samples for resistivity analysis were generally collected at approximate five-foot intervals and were representative of each stratigraphic unit encountered. One to two samples were taken from each of the units represented. The sample intervals for SR-Boring 1 were based on previously completed soil boring of CMT-1/ TS-01. SR-boring 2 was first drilled to determine the stratigraphic units. Once sample intervals were determined, an offset boring was drilled to collect the samples. All soil samples were collected for soil resistivity analyses by removing the polyacetate liner, using a hand saw to cut the approximate length of the sample (1 to 2 feet in length) and using duct tape to seal off the ends of each sample, keeping as much moisture in the liners as possible. Upon collection, soil samples were placed in a cooler, packed with bubble wrap to minimize movement and transported to FedEx using chain-of-custody protocols. After completion, the boreholes were backfilled with bentonite.

The soil resistivity testing results are summarized in a report from Kemron provided as Attachment 3. The soil resistivity ranges from 1,600 (Ω·cm) to 16,000 (Ω·cm) for the SR-Boring 1 samples, and from 1,600 (Ω·cm) to 9,000 (Ω·cm) for the SR-Boring 2 samples. Moisture content and soil density were also reported by Kemron.

In addition to the soil resistivity samples collected, Ramboll Environ also sampled groundwater from P-1, P-2, P-3, Sump and MW-27R on March 17, 2016 for analysis of hardness and total iron. The method of groundwater sampling was via a grab sample using a disposable bailer. New disposable bailers were used at each location. Analytical results are summarized on Table 1, provided in Attachment 4. Hardness as Calcium ranges from 231,000 µg/L at P-2 to 1,050,000 µg/L at P-3. Hardness as Magnesium ranges from 76,000 µg/L at P-2 to 410,000 µg/L at P-3. Total Iron ranges from 200 µg/L at Sump to 102,000 µg/L at P-3. Laboratory reports are provided in Attachment 5 for reference.

ATTACHMENT 1
FIGURE 1



PLAN VIEW
(DURING DNAPL AREA P&T PHASE)

DNAPL CONTAINMENT AREA - SOIL AND MONITORING WELL LOCATIONS
THIRD SITE

RAMBOLL ENVIRON

FIGURE
1

DRAFTED BY: CKL | DATE: 4/5/16 | 2131365J

ATTACHMENT 2
BORING LOGS

RAMBOLL ENVIRON
One Indiana Square
Indianapolis, Indiana 46204

Soil Boring
SR Boring -1
TOTAL DEPTH: 34.5 feet bgs

PROJECT: **Third Site**
SITE LOCATION: **Zionsville, Indiana**
DATE OF COMPLETION: **3/17/2016**
LOGGED BY: **Marjory Fure (5/10/2013)**
CMT-01 / TS-01

TOP OF CASING ELEVATION (feet AMSL): 881.957
GROUND SURFACE ELEVATION (feet AMSL): 878.178
DEPTH TO BOTTOM (feet BTOC): --
TOP OF SCREEN ELEVATION (feet AMSL): --
BOTTOM OF SCREEN ELEVATION (feet AMSL): --

NORTHING: 921238.377
EASTING: 725714.609

DRILLING COMPANY: SCS Contractors
DRILLING METHOD: Direct Push

ELEVATION (feet amsl)	RECOVERY	PID (ppm)	WELL CONSTRUCTION	LITHOLOGIC UNITS	DEPTH (feet bgs)	Soil Samples	DESCRIPTION
0.00					0		**CLAYEY SAND (SC):** Dark brown (10YR 4/3), moist, 70% fine to medium sand, 30% low plasticity fines [TOPSOIL]
-1.00		0.0			1		**POORLY GRADED SAND WITH SILT (SP-SM):** Reddish yellow (5YR 7/6), wet, 90% fine to coarse sand, 10% low plasticity fines [FILL].
-2.00	2.5				2		
-3.00					3		
-4.00					4		
-5.00		0.0			5		
-6.00	2.5				6		**SILTY SAND (SM):** Gray (10YR 5/1), wet, 20 % fine to medium sand, 20% low plasticity fines.
-7.00					7		
-8.00					8		
-9.00					9		
-10.00	4.0				10		black (10YR 2/1) sandy silt with organic matter
							SILT (ML): Gray (10YR 5/1), moist, 90% fines, 10% coarse sand, low plasticity, firm.
-11.00					11		
-12.00					12		
-13.00		0.4			13		
-14.00	4.0				14		
-15.00		0.1			15		
-16.00					16		hard
-17.00		0.0			17		sand lens
-18.00	3.0				18		sand lens
-19.00		0.2			19		
-20.00					20		

Notes: Boring SR Boring 1 adjacent to CMT-1 which was advanced on 5-10-13 for the 2014 DNAPL Contaiment Area Supplemental Data Collection

RAMBOLL ENVIRON

One Indiana Square
Indianapolis, Indiana 46204

Soil Boring
SR Boring -1
TOTAL DEPTH: 34.5 feet bgs

PROJECT: **Third Site**
SITE LOCATION: **Zionsville, Indiana**
DATE OF COMPLETION: **5/10/2013**
LOGGED BY: **Marjory Fure**

TOP OF CASING ELEVATION (feet AMSL): 881.957
GROUND SURFACE ELEVATION (feet AMSL): 878.178
DEPTH TO BOTTOM (feet BTOC): --
TOP OF SCREEN ELEVATION (feet AMSL): --
BOTTOM OF SCREEN ELEVATION (feet AMSL): --

NORTHING: 921238.377
EASTING: 725714.609

DRILLING COMPANY: SCS Contractors
DRILLING METHOD: Direct Push

ELEVATION (feet amsl)	RECOVERY	PID (ppm)	WELL CONSTRUCTION	LITHOLOGIC UNITS	DEPTH (feet bgs)	Soil Samples	DESCRIPTION
-20.00					20		**SILTY SAND (SM):** Gray (10YR 5/1), wet, 55% fine to coarse sand, 10% fine gravel, 35% low plasticity fines.
-21.00		0.0			21		
-22.00	3.0				22		
-23.00					23		
-24.00					24		**WELL GRADED SAND (SW):** Gray (10YR 5/1), wet, 85% fine to coarse sand, 10% fine gravel, 5% low plasticity fines
-25.00		0.0			25		**POORLY GRADED GRAVEL (GP):** Gray 10YR 5/1), wet, 60% fine gravel, 35% medium to coarse sand, 5% low plasticity fines.
-26.00	2.5				26		
-27.00					27		
-28.00					28		**WELL GRADED SAND (SW):** Gray (10YR 5/1), wet, 75% fine to coarse sand, 20% fine gravel, 5% low plasticity fines
-29.00		0.0			29		
-30.00	3.0				30		
-31.00					31		
-32.00					32		
-33.00					33		Bottom of direct push boring at 33 feet bgs
-34.00					34		
-35.00					35		
-36.00					36		
-37.00					37		
-38.00					38		
-39.00					39		
-40.00					40		

Notes: Soil stratigraphy based on CMT-01 / TS-01. Soil samples collected on March 17, 2016 for soil resistivity analysis. An offset boring was installed for collection of the sample collected from 26-27.5'.

RAMBOLL ENVIRON
One Indiana Square
Indianapolis, Indiana 46204

Soil Boring
SR Boring -2
TOTAL DEPTH: 32 feet bgs

PROJECT: **Third Site**
SITE LOCATION: **Zionsville, Indiana**
DATE OF COMPLETION: **3/17/2016**
LOGGED BY: **Janel Powers**

TOP OF CASING ELEVATION (feet AMSL): --
GROUND SURFACE ELEVATION (feet AMSL): --
DEPTH TO BOTTOM (feet BTOC): --
TOP OF SCREEN ELEVATION (feet AMSL): --
BOTTOM OF SCREEN ELEVATION (feet AMSL): --

NORTHING:
EASTING:

DRILLING COMPANY: SCS Contractors
DRILLING METHOD: Direct Push

ELEVATION (feet amsl)	RECOVERY (%)	PID (ppm)	WELL CONSTRUCTION	LITHOLOGIC UNITS	DEPTH (feet bgs)	Soil Samples	DESCRIPTION
0.00					0		**Fill (AF)**: Grey to light brown, dry, top-soil
-1.00		0.0			1		
-2.00	10				2		
-3.00		0..0			3		
-4.00					4		
-5.00		0.0			5		
-6.00	50				6		
-7.00		0.0			7		**Clay (OH):** Dark Brown, slightly moist, stiff, high plasticity
-8.00					8		
-9.00		Gravel (0.4)			9		**Gravel (GW):** well-graded gravel, wet, <15% fine grained sand
-10.00	50				10		**Clay (OH)**: Grey, moist to wet, stiff, high plasticity
-11.00		0.0			11		
-12.00					12		
-13.00		0.0			13		
-14.00	75				14		
-15.00		0.0			15		**Gravely Sand (SwGw)**- Grey, well graded sands with well graded gravel, wet to saturated
-16.00					16		
-17.00		0.0			17		
-18.00	80				18		Large to medium gravel ,well graded and well rounded, wet
-19.00		0.0			19		
-20.00					20		

Notes: Soil boring logged using direct push drilling methods

RAMBOLL ENVIRON
One Indiana Square
Indianapolis, Indiana 46204

Soil Boring
SR Boring -2
TOTAL DEPTH: 32 feet bgs

PROJECT: **Third Site**
SITE LOCATION: **Zionsville, Indiana**
DATE OF COMPLETION: **3/17/2016**
LOGGED BY: **Janel Powers**

TOP OF CASING ELEVATION (feet AMSL): --
GROUND SURFACE ELEVATION (feet AMSL): --
DEPTH TO BOTTOM (feet BTOC): --
TOP OF SCREEN ELEVATION (feet AMSL): --
BOTTOM OF SCREEN ELEVATION (feet AMSL): --

NORTHING:
EASTING:

DRILLING COMPANY: SCS Contractors
DRILLING METHOD: Direct Push

ELEVATION (feet amsl)	RECOVERY	PID (ppm)	WELL CONSTRUCTION	LITHOLOGIC UNITS	DEPTH (feet bgs)	Soil Samples	DESCRIPTION
-20.00					20		
-21.00		0.0			21		Large to medium gravel, well-graded and well-rounded, wet
-22.00	35				22		
-23.00		0.0			23		
-24.00					24		
-25.00		0.0			25		
-26.00	75				26		
-27.00		0.0			27		
-28.00					28		
-29.00		0.0			29		
-30.00	80				30		**Silty Clay (OL)**- Grey, dry, little to no plasticity, some small gravel inclusions, hard
-31.00		0.0			31		
-32.00					32		**End of boring**
-33.00					33		
-34.00					34		
-35.00					35		
-36.00					36		
-37.00					37		
-38.00					38		
-39.00					39		
-40.00					40		

Notes:

ATTACHMENT 3
SOIL RESISTIVITY TESTING RESULTS

KEMRON
ENVIRONMENTAL SERVICES

1359-A Ellsworth Industrial Blvd • Atlanta, GA 30318 • TEL 404-636-0928 • FAX 404-636-7162

March 30, 2016

Geosyntec Consultants, Inc.
130 Stone Road West
Guelph, Ontario, Canada, N1G 3Z2

Re: Final Letter Report of Geotechnical Testing
Third Site, Zionsville,IN
KEMRON ATG Project #SH0611

Dear Mr Major:

Enclosed, please find the testing results for the 13 samples received on March 21, 2016 for Geotechnical testing. :

This letter report includes the supporting laboratory data and the sample chain of custody. The following methods were completed for the referenced samples:

Soil Resistivity- ASTM G187
Moisture Content- ASTM D2216
Bulk Unit Weight- ASTM D7263

KEMRON Environmental Services, Inc. appreciates this opportunity to provide laboratory services to Geosyntec. If you have any questions, or require additional information, please contact me at (404) 636-0928.

Sincerely,

KEMRON Environmental Services, Inc.

Tommy A. Jordan, P.G.
Program Manager

Attachments: Summary Table of Results
Resistivity, Density, and Moisture Content Data Sheets
Chain of Custody

Geosyntec
Third Site
Geotechnical Testing
KEMRON PROJECT No. SH0611

Table 1

Summary Table of Results

KEMRON Sample Number	UD Density Dentermination ASTM D7263		Natural Moisture Content ASTM D2216		Resistivity ASTM G187
	Wet Density (lb/ft^3)	Dry Density (lb/ft^3)	ASTM Moisture Content (%)	Percent Solids (%)	($\Omega\cdot$cm)
SR Boring-1 (2.5-4)	107.0	96.5	10.90	90.17	16,000
SR Boring-1 (6.5-8)	128.3	114.0	12.52	88.87	9,300
SR Boring-1 (13.2-14.8)	139.8	125.8	11.11	90	2,300
SR Boring-1 (17.2-18.8)	141.4	128.9	9.74	91.12	1,600
SR Boring-1 (21.7-23)	138.7	122.6	13.08	88.43	1,600
SR Boring-1 (26-27.5)	102.7	89.9	14.30	87.49	2,300
SR Boring-1 (31.5-33)	117.5	99.4	18.13	84.65	1,700
SR Boring-2 (2.5-4)	120.7	102.7	17.53	85.08	3,400
SR Boring-2 (9-10)	114.8	105.7	8.61	92.08	9,000
SR Boring-2 (12.5-14)	146.0	132.0	10.65	90.37	2,700
SR Boring-2 (18.5-20)	104.9	95.8	9.44	91.37	8,200
SR Boring-2 (27-28.5)	104.3	99.3	5.10	95.15	5,500
SR Boring-2 (30-32)	120.7	111.9	7.88	92.69	1,600

Notes:
% = Percent
lb/ft^3 = pounds per cubic foot
($\Omega\cdot$cm) = ohms centimeters
UD = Undisturbed Sample
WC = Woodard and Curran

Material Resistivity

ASTM METHOD G187-05
DATA SHEET

PROJECT: Third Site
PROJECT No.: SH0611
TESTING DATE: 3/25/2016
TESTED BY: DMC
TRACKING CODE: A702-A714

Sample ID	Meter Reading Ω	Multiplier	Resistivity (Ω·cm)
1. SR Boring-1 (2.5-4)	1.6	10000	16,000
2. SR Boring-1 (6.5-8)	9.3	1000	9,300
3. SR Boring-1 (13.2-14.8)	2.3	1000	2,300
4. SR Boring-1 (17.2-18.8)	1.6	1000	1,600
5. SR Boring-1 (21.7-23)	1.6	1000	1,600
6. SR Boring-1 (26-27.5)	2.3	1000	2,300
7. SR Boring-1 (31.5-33)	1.7	1000	1,700
8. SR Boring-2 (2.5-4)	3.4	1000	3,400
9. SR Boring-2 (9-10)	9.0	1000	9,000
10. SR Boring-2 (12.5-14)	2.7	1000	2,700
11 SR Boring-2 (18.5-20)	8.2	1000	8,200
10. SR Boring-2 (27-28.5)	5.5	1000	5,500
10. SR Boring-2 (30-32)	1.6	1000	1,600

Note: The soil boxes are designed such that the cross-sectional area of the soil or liquid sample, with the box filled level, divided by the separation between the pins is equal to 1 cm.

RESISTIVITY, DENSITY, AND MOISTURE CONTENT DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-1 (2.5-4)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A702

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	113.13	g
3. WT OF MOLD + SOIL	378.18	g
4. WT OF WET SOIL, W	265.05	g
5. DIAMETER OF SPECIMEN, D	1.66	in
6. HEIGHT OF SPECIMEN, H	4.36	in
7. VOLUME OF SPECIMEN	9.44	in^3
8. WET DENSITY	107.0	pcf
9. DRY DENSITY	96.5	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	49.75	g
3. WT WET SOIL + TARE	113.23	g
4. WT DRY SOIL + TARE	106.99	g
5. WT WATER, Ww	6.24	g
6. WT DRY SOIL, Ws	57.24	g
7. ASTM MOISTURE CONTENT, W	10.90	%
8. EPA MOISTURE CONTENT, W	9.83	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-1 (6.5-8)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A703_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	113.20	g
3. WT OF MOLD + SOIL	425.29	g
4. WT OF WET SOIL, W	312.09	g
5. DIAMETER OF SPECIMEN, D	1.67	in
6. HEIGHT OF SPECIMEN, H	4.23	in
7. VOLUME OF SPECIMEN	9.27	in^3
8. WET DENSITY	128.3	pcf
9. DRY DENSITY	114.0	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	50.94	g
3. WT WET SOIL + TARE	108.27	g
4. WT DRY SOIL + TARE	101.89	g
5. WT WATER, Ww	6.38	g
6. WT DRY SOIL, Ws	50.95	g
7. ASTM MOISTURE CONTENT, W	12.52	%
8. EPA MOISTURE CONTENT, W	11.13	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-1 (13.2-14.8)
TESTING DATE:	3/25/16
TESTED BY:	TAJ/DMC
TRACKING CODE:	A704_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	0.00	g
3. WT OF MOLD + SOIL	335.69	g
4. WT OF WET SOIL, W	335.69	g
5. DIAMETER OF SPECIMEN, D	1.64	in
6. HEIGHT OF SPECIMEN, H	4.33	in
7. VOLUME OF SPECIMEN	9.15	in^3
8. WET DENSITY	139.8	pcf
9. DRY DENSITY	125.8	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	49.20	g
3. WT WET SOIL + TARE	93.90	g
4. WT DRY SOIL + TARE	89.43	g
5. WT WATER, Ww	4.47	g
6. WT DRY SOIL, Ws	40.23	g
7. ASTM MOISTURE CONTENT, W	11.11	%
8. EPA MOISTURE CONTENT, W	10.00	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-1 (17.2-18.8)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A705_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	20.33	g
3. WT OF MOLD + SOIL	369.27	g
4. WT OF WET SOIL, W	348.94	g
5. DIAMETER OF SPECIMEN, D	1.69	in
6. HEIGHT OF SPECIMEN, H	4.19	in
7. VOLUME OF SPECIMEN	9.40	in^3
8. WET DENSITY	141.4	pcf
9. DRY DENSITY	128.9	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	49.67	g
3. WT WET SOIL + TARE	92.14	g
4. WT DRY SOIL + TARE	88.37	g
5. WT WATER, Ww	3.77	g
6. WT DRY SOIL, Ws	38.70	g
7. ASTM MOISTURE CONTENT, W	9.74	%
8. EPA MOISTURE CONTENT, W	8.88	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-1 (21.7-23)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A706_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	21.92	g
3. WT OF MOLD + SOIL	378.81	g
4. WT OF WET SOIL, W	356.89	g
5. DIAMETER OF SPECIMEN, D	1.66	in
6. HEIGHT OF SPECIMEN, H	4.53	in
7. VOLUME OF SPECIMEN	9.80	in^3
8. WET DENSITY	138.7	pcf
9. DRY DENSITY	122.6	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	48.48	g
3. WT WET SOIL + TARE	105.80	g
4. WT DRY SOIL + TARE	99.17	g
5. WT WATER, Ww	6.63	g
6. WT DRY SOIL, Ws	50.69	g
7. ASTM MOISTURE CONTENT, W	13.08	%
8. EPA MOISTURE CONTENT, W	11.57	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-1 (26-27.5)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A707_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	45.84	g
3. WT OF MOLD + SOIL	390.80	g
4. WT OF WET SOIL, W	344.96	g
5. DIAMETER OF SPECIMEN, D	1.89	in
6. HEIGHT OF SPECIMEN, H	4.56	in
7. VOLUME OF SPECIMEN	12.79	in^3
8. WET DENSITY	102.7	pcf
9. DRY DENSITY	89.9	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	49.05	g
3. WT WET SOIL + TARE	95.08	g
4. WT DRY SOIL + TARE	89.32	g
5. WT WATER, Ww	5.76	g
6. WT DRY SOIL, Ws	40.27	g
7. ASTM MOISTURE CONTENT, W	14.30	%
8. EPA MOISTURE CONTENT, W	12.51	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-1 (31.5-33)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A708_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	22.12	g
3. WT OF MOLD + SOIL	362.50	g
4. WT OF WET SOIL, W	340.38	g
5. DIAMETER OF SPECIMEN, D	1.75	in
6. HEIGHT OF SPECIMEN, H	4.59	in
7. VOLUME OF SPECIMEN	11.04	in^3
8. WET DENSITY	117.5	pcf
9. DRY DENSITY	99.4	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	49.24	g
3. WT WET SOIL + TARE	107.50	g
4. WT DRY SOIL + TARE	98.56	g
5. WT WATER, Ww	8.94	g
6. WT DRY SOIL, Ws	49.32	g
7. ASTM MOISTURE CONTENT, W	18.13	%
8. EPA MOISTURE CONTENT, W	15.35	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-2 (2.5-4)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A709_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	0.00	g
3. WT OF MOLD + SOIL	142.02	g
4. WT OF WET SOIL, W	142.02	g
5. DIAMETER OF SPECIMEN, D	1.13	in
6. HEIGHT OF SPECIMEN, H	4.47	in
7. VOLUME OF SPECIMEN	4.48	in^3
8. WET DENSITY	120.7	pcf
9. DRY DENSITY	102.7	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	52.75	g
3. WT WET SOIL + TARE	114.36	g
4. WT DRY SOIL + TARE	105.17	g
5. WT WATER, Ww	9.19	g
6. WT DRY SOIL, Ws	52.42	g
7. ASTM MOISTURE CONTENT, W	17.53	%
8. EPA MOISTURE CONTENT, W	14.92	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-2 (9-10)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A710_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	21.36	g
3. WT OF MOLD + SOIL	226.95	g
4. WT OF WET SOIL, W	205.59	g
5. DIAMETER OF SPECIMEN, D	1.40	in
6. HEIGHT OF SPECIMEN, H	4.43	in
7. VOLUME OF SPECIMEN	6.82	in^3
8. WET DENSITY	114.8	pcf
9. DRY DENSITY	105.7	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	49.58	g
3. WT WET SOIL + TARE	115.58	g
4. WT DRY SOIL + TARE	110.35	g
5. WT WATER, Ww	5.23	g
6. WT DRY SOIL, Ws	60.77	g
7. ASTM MOISTURE CONTENT, W	8.61	%
8. EPA MOISTURE CONTENT, W	7.92	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-2 (12.5-14)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A711_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	0.00	g
3. WT OF MOLD + SOIL	188.86	g
4. WT OF WET SOIL, W	188.86	g
5. DIAMETER OF SPECIMEN, D	1.19	in
6. HEIGHT OF SPECIMEN, H	4.43	in
7. VOLUME OF SPECIMEN	4.93	in^3
8. WET DENSITY	146.0	pcf
9. DRY DENSITY	132.0	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	49.78	g
3. WT WET SOIL + TARE	149.80	g
4. WT DRY SOIL + TARE	140.17	g
5. WT WATER, Ww	9.63	g
6. WT DRY SOIL, Ws	90.39	g
7. ASTM MOISTURE CONTENT, W	10.65	%
8. EPA MOISTURE CONTENT, W	9.63	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-2 (18.5-20)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A712_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	21.06	g
3. WT OF MOLD + SOIL	203.89	g
4. WT OF WET SOIL, W	182.83	g
5. DIAMETER OF SPECIMEN, D	1.38	in
6. HEIGHT OF SPECIMEN, H	4.44	in
7. VOLUME OF SPECIMEN	6.64	in^3
8. WET DENSITY	104.9	pcf
9. DRY DENSITY	95.8	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	49.92	g
3. WT WET SOIL + TARE	147.42	g
4. WT DRY SOIL + TARE	139.01	g
5. WT WATER, Ww	8.41	g
6. WT DRY SOIL, Ws	89.09	g
7. ASTM MOISTURE CONTENT, W	9.44	%
8. EPA MOISTURE CONTENT, W	8.63	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-2 (27-28.5)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A713_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	24.66	g
3. WT OF MOLD + SOIL	325.05	g
4. WT OF WET SOIL, W	300.39	g
5. DIAMETER OF SPECIMEN, D	1.75	in
6. HEIGHT OF SPECIMEN, H	4.56	in
7. VOLUME OF SPECIMEN	10.97	in^3
8. WET DENSITY	104.3	pcf
9. DRY DENSITY	99.3	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	49.07	g
3. WT WET SOIL + TARE	133.95	g
4. WT DRY SOIL + TARE	129.83	g
5. WT WATER, Ww	4.12	g
6. WT DRY SOIL, Ws	80.76	g
7. ASTM MOISTURE CONTENT, W	5.10	%
8. EPA MOISTURE CONTENT, W	4.85	%

DENSITY DETERMINATION

DATA SHEET

PROJECT:	Third Site
PROJECT No.:	SH0611
SAMPLE No.:	SR Boring-2 (30-32)
TESTING DATE:	3/25/16
TESTED BY:	DMC
TRACKING CODE:	A714_DEN

UNIT WEIGHT (DENSITY)		
1. SAMPLE NO.	A	
2. WT OF MOLD (tare weight)	21.30	g
3. WT OF MOLD + SOIL	365.89	g
4. WT OF WET SOIL, W	344.59	g
5. DIAMETER OF SPECIMEN, D	1.75	in
6. HEIGHT OF SPECIMEN, H	4.52	in
7. VOLUME OF SPECIMEN	10.87	in^3
8. WET DENSITY	120.7	pcf
9. DRY DENSITY	111.9	pcf

MOISTURE CONTENT (Dry & Wet Basis)		
1. MOISTURE TIN NO.	A	
2. WT MOISTURE TIN (tare weight)	49.74	g
3. WT WET SOIL + TARE	105.03	g
4. WT DRY SOIL + TARE	100.99	g
5. WT WATER, Ww	4.04	g
6. WT DRY SOIL, Ws	51.25	g
7. ASTM MOISTURE CONTENT, W	7.88	%
8. EPA MOISTURE CONTENT, W	7.31	%

KEMRON ENVIRONMENTAL SERVICES, INC.
1359-A Ellsworth Industrial Boulevard, Atlanta, GA 30318
TEL.: (404) 636-0928 FAX: (404) 636-7162
www.KEMRON.com

CHAIN OF CUSTODY

Work Order:

Date: 03 / 17 / 16

Page 1 of 1

COMPANY: Ramboll Environ c/o Savron Solutions/Geosyntec

ADDRESS: One Indiana Square, Suite 2335 Indianapolis, IN 46204

PHONE: (317) 823-8716

FAX: (317) 823-8720

SAMPLED BY (PRINT): Janel Powers

SAMPLED BY (SIGNATURE):

No. of Containers	SAMPLE ID	SAMPLED DATE	SAMPLED TIME	GRAB	COMPOSITE	MATRIX	PRESERVATIVE	Soil Resistivity	Density	Moisture content										REMARKS
1	SR Boring-1 (2.5-4)	3/17/16	0940	x		Soil	N/A	✓	✓	✓									—	SR Boring-1
1	SR Boring-1 (6.5-8)		0943	x				✓	✓	✓									✓	all samples in
1	SR Boring-1 (13.2-14.8)		1000	x				✓	✓	✓										saturated zone
1	SR Boring-1 (17.2-18.8)		1014	x				✓	✓	✓										
1	SR Boring-1 (21.7-23)		1028	x				✓	✓	✓									—	
1	SR Boring-1 (26-27)		1150	x				✓	✓	✓									—	SR Boring-2
1	SR Boring-1 (31.5-33)		1105	x				✓	✓	✓									✓	(2.5-4) in vadose
1	SR Boring-2 (2.5-4)		13:25	x				✓	✓	✓									✓	zone all other
1	SR Boring-2 (9-10)		13:30	x				✓	✓	✓									✓	collected in saturated
1	SR Boring-2 (12.5-14)		13:35	x				✓	✓	✓									✓	zone
1	SR Boring-2 (18.5-20)		13:40	x				✓	✓	✓									—	
1	SR Boring-2 (27-28.5)		14:00	x				✓	✓	✓									—	
1	SR Boring-2 (30-32)	3/17/16	14:15	x				✓	✓	✓									—	

RELINQUISHED BY:	DATE/TIME:	RECEIVED BY:	DATE/TIME:
Janel Powers	3/18 11:00	Fed Ex	3/18 11:00
[signature]	3/21/16		

Turnaround Time Request (Business Days):

PROJECT INFORMATION:

PROJECT NAME: Third Site, Zionsville, IN

PROJECT No.

PO #

SEND REPORT TO: Doyle Major, Savron Solutions

SPECIAL INSTRUCTIONS/ COMMENTS:

REV 08/07/2013

ED_012957A_00000919-00083

ATTACHMENT 4
GROUNDWATER ANALYTICAL RESULTS

Table 1
Hardness and Total Iron in Groundwater
DNAPL Containment Area
Third Site Superfund Site, Zionsville, Indiana

Location ID	Hardness (Calcium)	Hardness (Magnesium)	Total Iron
P-1	419,000	156,000	52,000
P-2	231,000	76,000	2,060
P-3	1,050,000	410,000	102,000
Sump	379,000	271,000	200
MW-27R	676,000	308,000	49,200

Samples collected on March 17th 2016

All sample results reported in µg/L = micrograms per liter

ATTACHMENT 5
GROUNDWATER LABORATORY REPORTS

Pace Analytical®
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4860 Blazer Parkway
Dublin, OH 43017
(614)486-5421

Pace Analytical Services, Inc.
7726 Moller Road
Indianapolis, IN 46268
(317)228-3100

March 28, 2016

Mr. Chuck Goodwin
Ramboll Environ
One Indiana Square
Suite 2335
Indianapolis, IN 46204

RE: Project: Third Site
Pace Project No.: 50140780

Dear Mr. Goodwin:

Enclosed are the analytical results for sample(s) received by the laboratory on March 17, 2016. The results relate only to the samples included in this report. Results reported herein conform to the most current TNI standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Mick Mayse

Mick Mayse
mick.mayse@pacelabs.com
Project Manager

Enclosures

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CERTIFICATIONS

Project:	Third Site
Pace Project No.:	50140780

Indiana Certification IDs

7726 Moller Road, Indianapolis, IN 46268
Illinois Certification #: 200074
Indiana Certification #: C-49-06
Kansas/NELAP Certification #:E-10177
Kentucky UST Certification #: 0042
Kentucky WW Certification #:98019
Ohio VAP Certification #: CL-0065
Oklahoma Certification #: 2014-148
Texas Certification #: T104704355-15-9
West Virginia Certification #: 330
Wisconsin Certification #: 999788130
USDA Soil Permit #: P330-10-00128

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SAMPLE SUMMARY

Project: Third Site
Pace Project No.: 50140780

Lab ID	Sample ID	Matrix	Date Collected	Date Received
50140780001	**P-3**	Water	03/17/16 14:50	03/17/16 16:10
50140780002	**P-1**	Water	03/17/16 14:58	03/17/16 16:10
50140780003	**P-2**	Water	03/17/16 15:05	03/17/16 16:10
50140780004	**MW-27R**	Water	03/17/16 15:12	03/17/16 16:10
50140780005	**SUMP**	Water	03/17/16 15:20	03/17/16 16:10

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SAMPLE ANALYTE COUNT

Project: Third Site
Pace Project No.: 50140780

Lab ID	Sample ID	Method	Analysts	Analytes Reported
50140780001	**P-3**	EPA 6010	MJC	3
50140780002	**P-1**	EPA 6010	MJC	3
50140780003	**P-2**	EPA 6010	MJC	3
50140780004	**MW-27R**	EPA 6010	MJC	3
50140780005	**SUMP**	EPA 6010	MJC	3

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SUMMARY OF DETECTION

Project: Third Site
Pace Project No.: 50140780

Lab Sample ID / Method	Client Sample ID / Parameters	Result	Units	Report Limit	Analyzed	Qualifiers
50140780001	**P-3**					
EPA 6010	Hardness, Calcium	419000	ug/L	1000	03/24/16 11:14	
EPA 6010	Hardness, Magnesium	156000	ug/L	1000	03/24/16 11:14	
EPA 6010	Iron	52000	ug/L	100	03/24/16 11:14	
50140780002	**P-1**					
EPA 6010	Hardness, Calcium	231000	ug/L	1000	03/24/16 11:16	
EPA 6010	Hardness, Magnesium	76000	ug/L	1000	03/24/16 11:16	
EPA 6010	Iron	2060	ug/L	100	03/24/16 11:16	
50140780003	**P-2**					
EPA 6010	Hardness, Calcium	1050000	ug/L	20000	03/24/16 12:35	
EPA 6010	Hardness, Magnesium	410000	ug/L	1000	03/24/16 11:19	
EPA 6010	Iron	102000	ug/L	100	03/24/16 11:19	
50140780004	**MW-27R**					
EPA 6010	Hardness, Calcium	676000	ug/L	20000	03/24/16 12:37	
EPA 6010	Hardness, Magnesium	308000	ug/L	1000	03/24/16 11:21	
EPA 6010	Iron	49200	ug/L	100	03/24/16 11:21	
50140780005	**SUMP**					
EPA 6010	Hardness, Calcium	379000	ug/L	1000	03/24/16 11:23	
EPA 6010	Hardness, Magnesium	271000	ug/L	1000	03/24/16 11:23	
EPA 6010	Iron	200	ug/L	100	03/24/16 11:23	

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ANALYTICAL RESULTS

Project: Third Site
Pace Project No.: 50140780

Sample: P-3 **Lab ID: 50140780001** Collected: 03/17/16 14:50 Received: 03/17/16 16:10 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Hardness, Calcium	**419000**	ug/L	1000	500	1	03/21/16 18:26	03/24/16 11:14		
Hardness, Magnesium	**156000**	ug/L	1000	500	1	03/21/16 18:26	03/24/16 11:14		
Iron	**52000**	ug/L	100	13.4	1	03/21/16 18:26	03/24/16 11:14	7439-89-6	

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ANALYTICAL RESULTS

Project: Third Site
Pace Project No.: 50140780

Sample: P-1 **Lab ID: 50140780002** Collected: 03/17/16 14:58 Received: 03/17/16 16:10 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Hardness, Calcium	**231000**	ug/L	1000	500	1	03/21/16 18:26	03/24/16 11:16		
Hardness, Magnesium	**76000**	ug/L	1000	500	1	03/21/16 18:26	03/24/16 11:16		
Iron	**2060**	ug/L	100	13.4	1	03/21/16 18:26	03/24/16 11:16	7439-89-6	

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ANALYTICAL RESULTS

Project: Third Site
Pace Project No.: 50140780

Sample: P-2 **Lab ID: 50140780003** Collected: 03/17/16 15:05 Received: 03/17/16 16:10 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Hardness, Calcium	**1050000**	ug/L	20000	10000	20	03/21/16 18:26	03/24/16 12:35		
Hardness, Magnesium	**410000**	ug/L	1000	500	1	03/21/16 18:26	03/24/16 11:19		
Iron	**102000**	ug/L	100	13.4	1	03/21/16 18:26	03/24/16 11:19	7439-89-6	

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ANALYTICAL RESULTS

Project: Third Site
Pace Project No.: 50140780

Sample: MW-27R **Lab ID: 50140780004** Collected: 03/17/16 15:12 Received: 03/17/16 16:10 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Hardness, Calcium	**676000**	ug/L	20000	10000	20	03/21/16 18:26	03/24/16 12:37		
Hardness, Magnesium	**308000**	ug/L	1000	500	1	03/21/16 18:26	03/24/16 11:21		
Iron	**49200**	ug/L	100	13.4	1	03/21/16 18:26	03/24/16 11:21	7439-89-6	

REPORT OF LABORATORY ANALYSIS

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ANALYTICAL RESULTS

Project: Third Site
Pace Project No.: 50140780

Sample: SUMP **Lab ID: 50140780005** Collected: 03/17/16 15:20 Received: 03/17/16 16:10 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP	Analytical Method: EPA 6010 Preparation Method: EPA 3010								
Hardness, Calcium	**379000**	ug/L	1000	500	1	03/21/16 18:26	03/24/16 11:23		
Hardness, Magnesium	**271000**	ug/L	1000	500	1	03/21/16 18:26	03/24/16 11:23		
Iron	**200**	ug/L	100	13.4	1	03/21/16 18:26	03/24/16 11:23	7439-89-6	

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QUALITY CONTROL DATA

Project: Third Site
Pace Project No.: 50140780

QC Batch: MPRP/20173 Analysis Method: EPA 6010
QC Batch Method: EPA 3010 Analysis Description: 6010 MET
Associated Lab Samples: 50140780001, 50140780002, 50140780003, 50140780004, 50140780005

METHOD BLANK: 1501419 Matrix: Water
Associated Lab Samples: 50140780001, 50140780002, 50140780003, 50140780004, 50140780005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Hardness, Calcium	ug/L	1480	1000	500	03/24/16 11:05	
Hardness, Magnesium	ug/L	ND	1000	500	03/24/16 11:05	
Iron	ug/L	ND	100	13.4	03/24/16 11:05	

LABORATORY CONTROL SAMPLE: 1501420

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Hardness, Calcium	ug/L	25000	25700	103	80-120	
Hardness, Magnesium	ug/L	41200	41100	100	80-120	
Iron	ug/L	10000	10200	102	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1501421 1501422

Parameter	Units	50140867009 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Hardness, Calcium	ug/L	913000	25000	25000	958000	920000	180	29	75-125	4	20	
Hardness, Magnesium	ug/L	527000	41200	41200	579000	553000	127	65	75-125	5	20	
Iron	ug/L	153000	10000	10000	164000	158000	111	48	75-125	4	20	P6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

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QUALIFIERS

Project:	Third Site
Pace Project No.:	50140780

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

ANALYTE QUALIFIERS

P6 Matrix spike recovery was outside laboratory control limits due to a parent sample concentration notably higher than the spike level.

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: Third Site
Pace Project No.: 50140780

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
50140780001	**P-3**	EPA 3010	MPRP/20173	EPA 6010	ICP/24752
50140780002	**P-1**	EPA 3010	MPRP/20173	EPA 6010	ICP/24752
50140780003	**P-2**	EPA 3010	MPRP/20173	EPA 6010	ICP/24752
50140780004	**MW-27R**	EPA 3010	MPRP/20173	EPA 6010	ICP/24752
50140780005	**SUMP**	EPA 3010	MPRP/20173	EPA 6010	ICP/24752

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CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: 1 of 1

2044370

Section A
Required Client Information:

Company: Ramboll Environ
Address: One Indiana Square suite 2335
Indianapolis IN 46204
Email To: CGoodwin@ramboll.com
Phone: 317-803-4603 Fax: –
Requested Due Date/TAT: std

Section B
Required Project Information:

Report To: Charles Goodwin
Copy To:
Purchase Order No.:
Project Name: Third site
Project Number: 2131365J

Section C
Invoice Information:

Attention: same
Company Name:
Address:
Pace Quote Reference:
Pace Project Manager: Mick Mayse
Pace Profile #:

REGULATORY AGENCY

- NPDES
- GROUND WATER
- DRINKING WATER
- UST
- RCRA
- OTHER

Site Location STATE: IN

Section D
Required Client Information

SAMPLE ID
(A-Z, 0-9 / ,-)
Sample IDs MUST BE UNIQUE

Matrix Codes

MATRIX	CODE
Drinking Water	DW
Water	WT
Waste Water	WW
Product	P
Soil/Solid	SL
Oil	OL
Wipe	WP
Air	AR
Tissue	TS
Other	OT

Requested Analysis Filtered (Y/N)

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED COMPOSITE START DATE	COMPOSITE START TIME	COMPOSITE END/GRAB DATE	COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test Y/N	Hardness Ca	Hardness Mg	total iron	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D. 50140780
1	P3	WT	G			02-17-16	14:50		1														001
2	R1						14:58		1														002
3	P2						15:05		1														003
4	MW-27R						15:12		1														004
5	Sump					02-17-16	15:20		1														005
6																							
7																							
8																							
9																							
10																							
11																							
12																							

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)
all samples Boiled	[signature]	3/17/16	4:10	[signature]	3/17/16	4:10	7.3	Y	N	Y

ORIGINAL

SAMPLER NAME AND SIGNATURE
PRINT Name of SAMPLER: Janel Paver
SIGNATURE of SAMPLER: [signature]
DATE Signed (MM/DD/YY): 02-17-16

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

F-ALL-Q-020rev.07, 15-May-2007

Sample Condition Upon Receipt

PaceAnalytical

Client Name: Ramboll Environ Project # 50140780

Courier: ☐ Fed Ex ☐ UPS ☐ USPS ☑ Client ☐ Commercial ☐ Pace Other

Tracking #:

Custody Seal on Cooler/Box Present: ☐ yes ☑ no Seals intact: ☐ yes ☑ no

Date/Time 5035A kits placed in freezer

Packing Material: ☐ Bubble Wrap ☐ Bubble Bags ☑ None ☐ Other

Thermometer 1 2 3 4 5 6 A B C D E F Type of Ice: Wet Blue None ☐ Samples on ice, cooling process has begun

Cooler Temperature (Initial/Corrected) 7.3/7.3 Ice Visible in Sample Containers: ☐ yes ☑ no

Temp should be above freezing to 6°C

Date and Initials of person examining contents: NB 3/17/16

		Comments:
Are samples from West Virginia? Document any containers out of temp.	☐Yes ☑No	1.
Chain of Custody Present:	☑Yes ☐No ☐N/A	2.
Chain of Custody Filled Out:	☑Yes ☐No ☐N/A	3.
Chain of Custody Relinquished:	☑Yes ☐No ☐N/A	4.
Sampler Name & Signature on COC:	☑Yes ☐No ☐N/A	5.
Short Hold Time Analysis (<72hr):	☐Yes ☑No ☐N/A	6.
Rush Turn Around Time Requested:	☐Yes ☑No ☐N/A	7.
Containers Intact:	☑Yes ☐No ☐N/A	8.
Sample Labels match COC: -Includes date/time/ID/Analysis	☑Yes ☐No ☐N/A	9.
All containers needing acid/base pres. have been checked? exceptions: VOA, coliform, TOC, O&G All containers needing preservation are found to be in compliance with EPA recommendation (<2, >9, >12) unless otherwise noted.	☑Yes ☐No ☐N/A	10 (Circle) HNO3 H2SO4 NaOH NaOH/ZnAc
Residual Chlorine Check (SVOC 625 Pest/PCB 608)		11. Present Absent
Residual Chlorine Check (Total/Amenable/Free Cyanide)		12. Present Absent
Headspace in VOA Vials (>6mm):	☐Yes ☐No ☑N/A	13
Headspace Wisconsin Sulfide	☐Yes ☐No	14
Trip Blank Present:	☐Yes ☑No ☐N/A	15
Trip Blank Custody Seals Present	☐Yes ☐No ☑N/A	
Project Manager Review		
Samples Arrived within Hold Time:	☑Yes ☐No ☐N/A	15.
Sufficient Volume:	☑Yes ☐No ☐N/A	16.
Correct Containers Used:	☑Yes ☐No ☐N/A	17.

Client Notification/ Resolution: Field Data Required? Y / N

Person Contacted: Date/Time:

Comments/ Resolution:

Project Manager Review: K. Jones **Date:** 3-18-16

Form F-IN-Q-290-rev.09, 13Oct2015

Sample Container Count

CLIENT: Ramboll Environ

COC PAGE 1 of 1
COC ID# 2044370

Project # S0140780

Sample Line Item	DG9H	AG1U	WGFU	AG0U	R 4 / 6	BP2N	BP2U	BP2S	BP3N	BP3U	BP3S	AG3S	AG1H	BP3C	BP1U	SP5T	AG2U					pH <2	pH >9	pH>12
1									1															
2									1															
3									1															
4									1															
5									1															
6																								
7																								
8																								
9																								
10																								
11																								
12																								

Container Codes

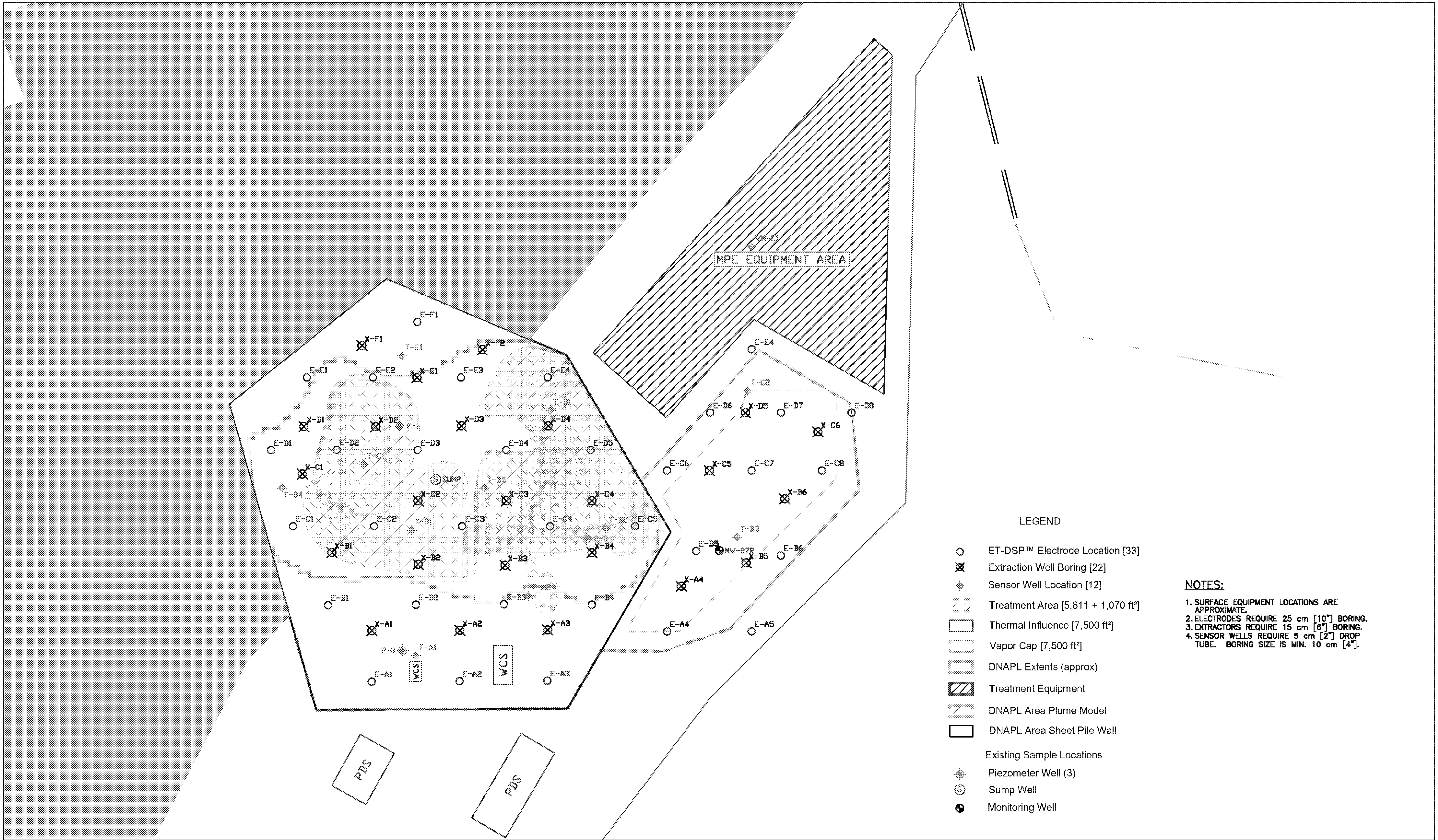
DG9H	40mL HCL amber voa vial	AG0U	100mL unpreserved amber glass	BP1N	1 liter HNO3 plastic	DG9P	40mL TSP amber vial
AG1U	1liter unpreserved amber glass	AG1H	1 liter HCL amber glass	BP1S	1 liter H2SO4 plastic	DG9S	40mL H2SO4 amber vial
WGFU	4oz clear soil jar	AG1S	1 liter H2SO4 amber glass	BP1U	1 liter unpreserved plastic	DG9T	40mL Na Thio amber vial
R	terra core kit	AG1T	1 liter Na Thiosulfate amber glass	BP1Z	1 liter NaOH, Zn, Ac	DG9U	40mL unpreserved **amber** vial
BP2N	500mL HNO3 plastic	AG2N	500mL HNO3 amber glass	BP2A	500mL NaOH, Asc Acid plastic	SP5T	120mL Coliform Na Thiosulfate
BP2U	500mL unpreserved plastic	AG2S	500mL H2SO4 amber glass	BP2O	500mL NaOH plastic	JGFU	4oz unpreserved amber wide
BP2S	500mL H2SO4 plastic	AG2U	500mL unpreserved amber glass	BP2Z	500mL NaOH, Zn Ac	U	Summa Can
BP3N	250mL HNO3 plastic	AG3U	250mL unpreserved amber glass	AF	Air Filter	VG9H	40mL HCL clear vial
BP3U	250mL unpreserved plastic	BG1H	1 liter HCL clear glass	BP3C	250mL NaOH plastic	VG9T	40mL Na Thio. clear vial
BP3S	250mL H2SO4 plastic	BG1S	1 liter H2SO4 clear glass	BP3Z	250mL NaOH, Zn Ac plastic	VG9U	40mL unpreserved **clear** vial
AG3S	250mL H2SO4 glass amber	BG1T	1 liter Na Thiosulfate clear glass	C	Air Cassettes	VSG	Headspace septa vial & HCL
AG1S	1 liter H2SO4 amber glass	BG1U	1 liter unpreserved glass	DG9B	40mL Na Bisulfate amber vial	WGFX	4oz wide jar w/hexane wipe
BP1U	1 liter unpreserved plastic	BP1A	1 liter NaOH, Asc Acid plastic	DG9M	40mL MeOH clear vial	ZPLC	Ziploc Bag

Appendix B – Thermal Model

Thermal Model numerical simulation report

Appendix C – Design Drawings

1. WFL-02 – Wellfield Layout
2. WCD-01 – DNAPL Area Well Completion Drawing
3. WCD-02 – ATT Area Well Completion Drawing
4. ESL-01 – Electrical Single Line
5. WHD-01 – Wellhead Detail



LEGEND

- ET-DSP™ Electrode Location [33]
- Extraction Well Boring [22]
- Sensor Well Location [12]
- Treatment Area [5,611 + 1,070 ft²]
- Thermal Influence [7,500 ft²]
- Vapor Cap [7,500 ft²]
- DNAPL Extents (approx)
- Treatment Equipment
- DNAPL Area Plume Model
- DNAPL Area Sheet Pile Wall

Existing Sample Locations

- Piezometer Well (3)
- Sump Well
- Monitoring Well

NOTES:

1. SURFACE EQUIPMENT LOCATIONS ARE APPROXIMATE.
2. ELECTRODES REQUIRE 25 cm [10"] BORING.
3. EXTRACTORS REQUIRE 15 cm [6"] BORING.
4. SENSOR WELLS REQUIRE 5 cm [2"] DROP TUBE. BORING SIZE IS MIN. 10 cm [4"].

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PH: 403.569.5100, FX: 403.272.7201

LPE

DATE

REV.	DATE (Yr/M/D)	DESCRIPTION	DRAWN BY	ORG/ ENGR	Aproved Dist
B2	2017/08/31	SENSOR WELL CHANGES	EJR	EJR	DAR
B1	2017/05/26	90% DESIGN	EJR	EJR	DAR

DRAWING NUMBER:

SCALE: NOT TO SCALE

TITLE:

ET-DSP™ Well Field Layout
Not for Construction

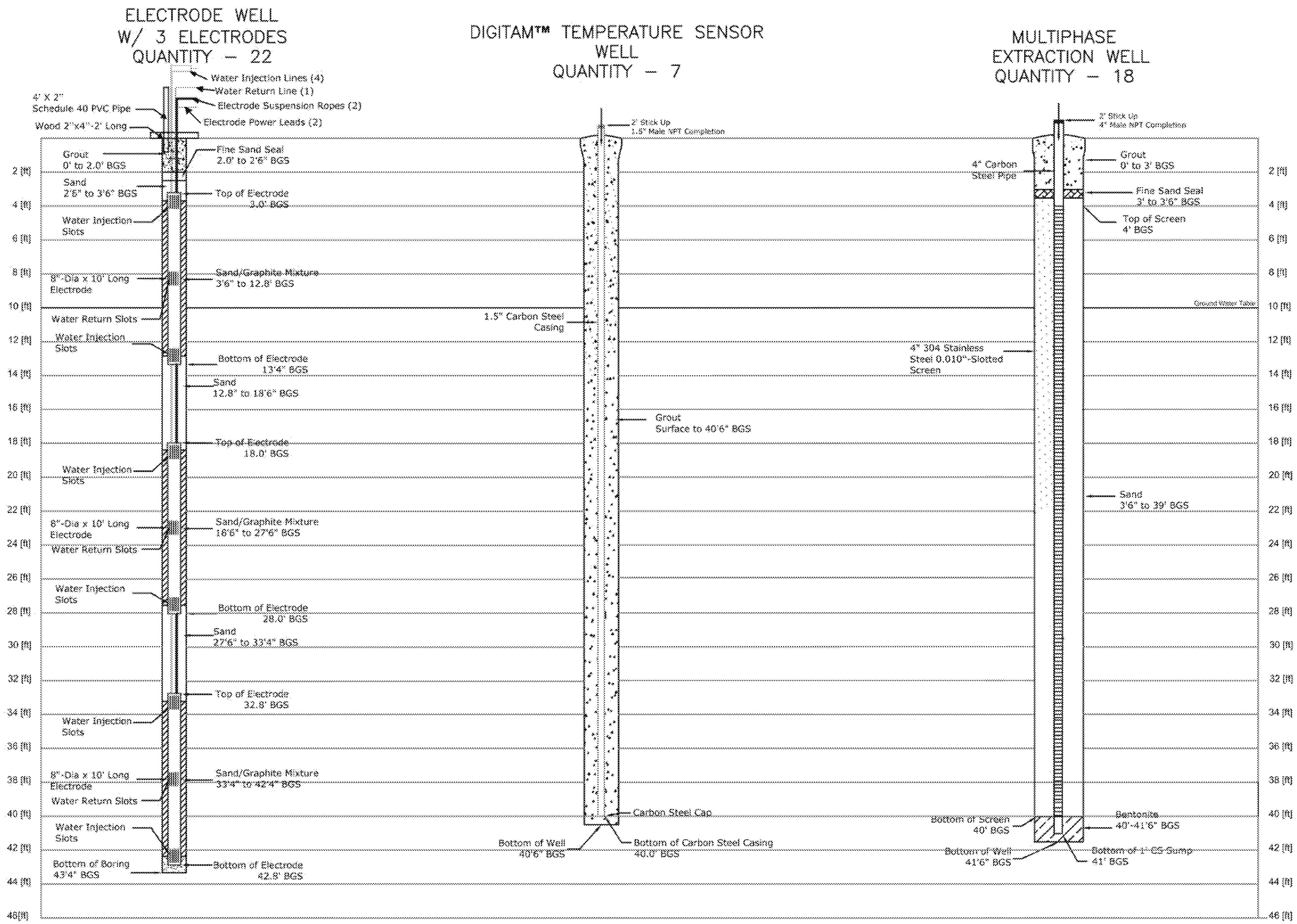
CLIENT:

Third Site Trust Fund
Third Site ERH
Zionsville, Indiana

SHEET:

WFL-02

ED_012957A_00000919-00105



GENERAL NOTES:

1. MATERIAL TYPES
   - A. GROUT
     - HIGH TEMPERATURE PORTLAND TYPE I/IV OR EQUIVALENT (NO BENTONITE)
   - B. SAND
     - ELECTRODE WELLS: 10 / 20 SILICA SAND OR EQUIVALENT
     - FINE SAND SEAL: 40 / 60 SILICA SAND OR EQUIVALENT
     - EXTRACTION WELLS: 20 / 40 SILICA SAND
   - C. GRAPHITE / SAND MIXTURE
     - 1:7 GRAPHITE TO SAND RATIO. 1:3 RATIO FOR UPPER ELECTRODES.
   - D. BENTONITE: MEDIUM CHIPS
2. ELECTRODE WELLS
   - A. MINIMUM 10" INSIDE DIAMETER TOOLING TO ACCOMMODATE 8" DIAMETER ELECTRODE
   - B. WATER RETURN LINE INCLUDED TO ALLEVIATE POSSIBLE LOCALIZED PRESSURE BUILD UP WITHIN ELECTRODE WELL.
3. TEMPERATURE WELLS
   - A. MINIMUM 4" DIAMETER BOREHOLE
   - B. 1.5" CARBON STEEL CASING
   - C. THREADS CAN BE NPT OR FLUSH JOINT, EXCEPT STICKUP MUST BE MALE NPT
   - D. ALL JOINTS TO BE TIGHTENED WITH PIPE WRENCH USING PIPE THREAD COMPOUND AND PTFE TAPE
4. EXTRACTION WELLS
   - A. MINIMUM 8" DIAMETER BOREHOLE
   - B. 4" CASING SIZE SCREEN C/W 0.010" OPENING
   - C. 4" NPT FEMALE X WELD PLATE ENDS
   - D. NOMINAL 4" DIAMETER WIRE-WRAPPED 304 STAINLESS STEEL 0.010"-SLOTTED SCREEN
   - E. FITTINGS BETWEEN PIPE SECTIONS ARE 4 THREAD PER INCH (TPI) FLUSH THREADED UNLESS SPECIFIED OTHERWISE (IE M NPT OR PLUG)

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B1	2016/07/12	99% DESIGN	MPK	EJR	DR	
REV.	DATE (YR/MM/DD)	DESCRIPTION	DRAWN BY	CHK'D ENGR	Approved Dist.	
APEGA PERMIT NUMBER:	P08178		SCALE: NOT TO SCALE			

EPE

DATE

TITLE:

ET-DSP™ Deep Well Construction Diagram

NOT FOR CONSTRUCTION

CLIENT:

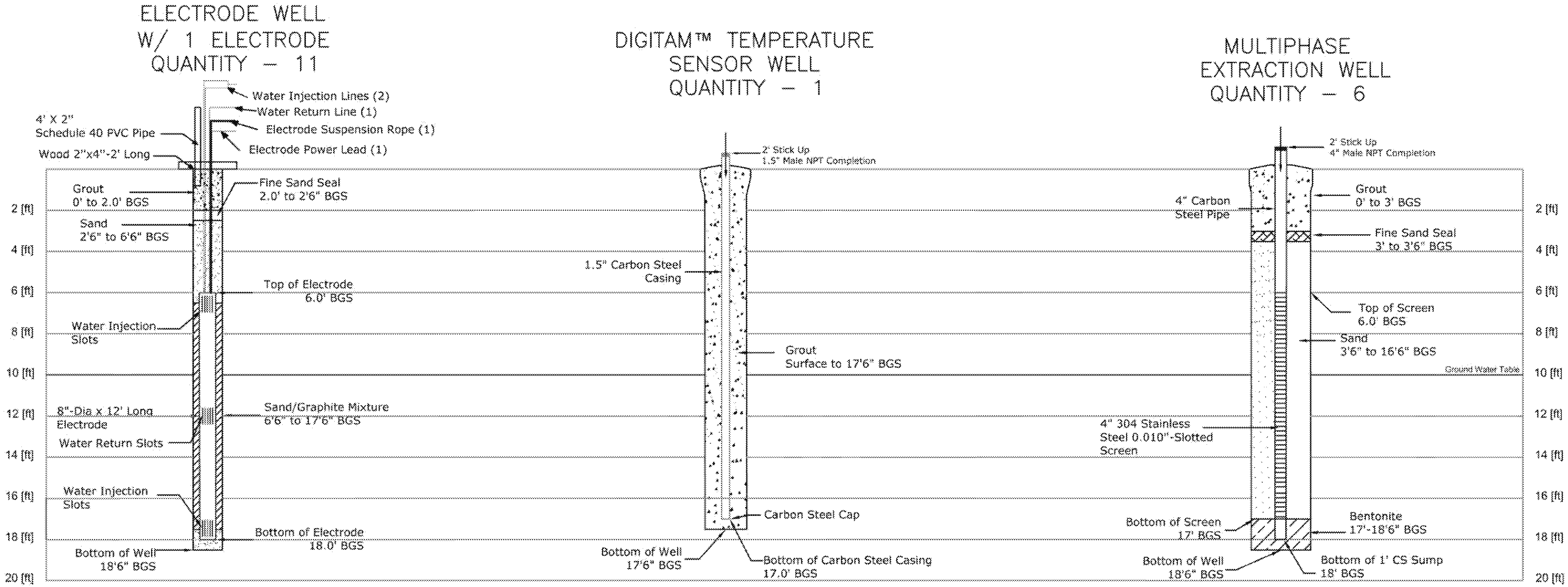
Third Site Trust Fund

Third Site ERH

Zionsville, Indiana

SHEET:

WCD-01



GENERAL NOTES:

1. MATERIAL TYPES
   - A. GROUT
     - HIGH TEMPERATURE PORTLAND TYPE I/IV OR EQUIVALENT (NO BENTONITE)
   - B. SAND
     - ELECTRODE WELLS: 10 / 20 SILICA SAND OR EQUIVALENT
     - FINE SAND SEAL: 40 / 60 SILICA SAND OR EQUIVALENT
     - EXTRACTION WELLS: 20 / 40 SILICA SAND
   - C. GRAPHITE / SAND MIXTURE
     - 1:3 GRAPHITE TO SAND RATIO
   - D. BENTONITE: MEDIUM CHIPS
2. ELECTRODE WELLS
   - A. MINIMUM 10" INSIDE DIAMETER TOOLING TO ACCOMMODATE 8" DIAMETER ELECTRODE
   - B. WATER RETURN LINE INCLUDED TO ALLEVIATE POSSIBLE LOCALIZED PRESSURE BUILD UP WITHIN ELECTRODE WELL.
3. TEMPERATURE WELLS
   - A. MINIMUM 4" DIAMETER BOREHOLE
   - B. 1.5" CARBON STEEL CASING
   - C. THREADS CAN BE NPT OR FLUSH JOINT, EXCEPT STICKUP MUST BE MALE NPT
   - D. ALL JOINTS TO BE TIGHTENED WITH PIPE WRENCH USING PIPE THREAD COMPOUND AND PTFE TAPE
4. EXTRACTION WELLS
   - A. MINIMUM 8" DIAMETER BOREHOLE
   - B. 4" CASING SIZE SCREEN C/W 0.010" OPENING
   - C. 4" NPT FEMALE X WELD PLATE ENDS
   - D. NOMINAL 4" DIAMETER WIRE-WRAPPED 304 STAINLESS STEEL 0.010"-SLOTTED SCREEN
   - E. FITTINGS BETWEEN PIPE SECTIONS ARE 4 THREAD PER INCH (TPI) FLUSH THREADED UNLESS SPECIFIED OTHERWISE (IE M NPT OR PLUG)

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LPE:

DATE:

REV.	DATE (YY/MM/DD)	DESCRIPTION	DRAWN BY	ORG/ ENGR	Aprroved Dist
01	2017/05/25	90% DESIGN REPORT	MPK	EJR	DR

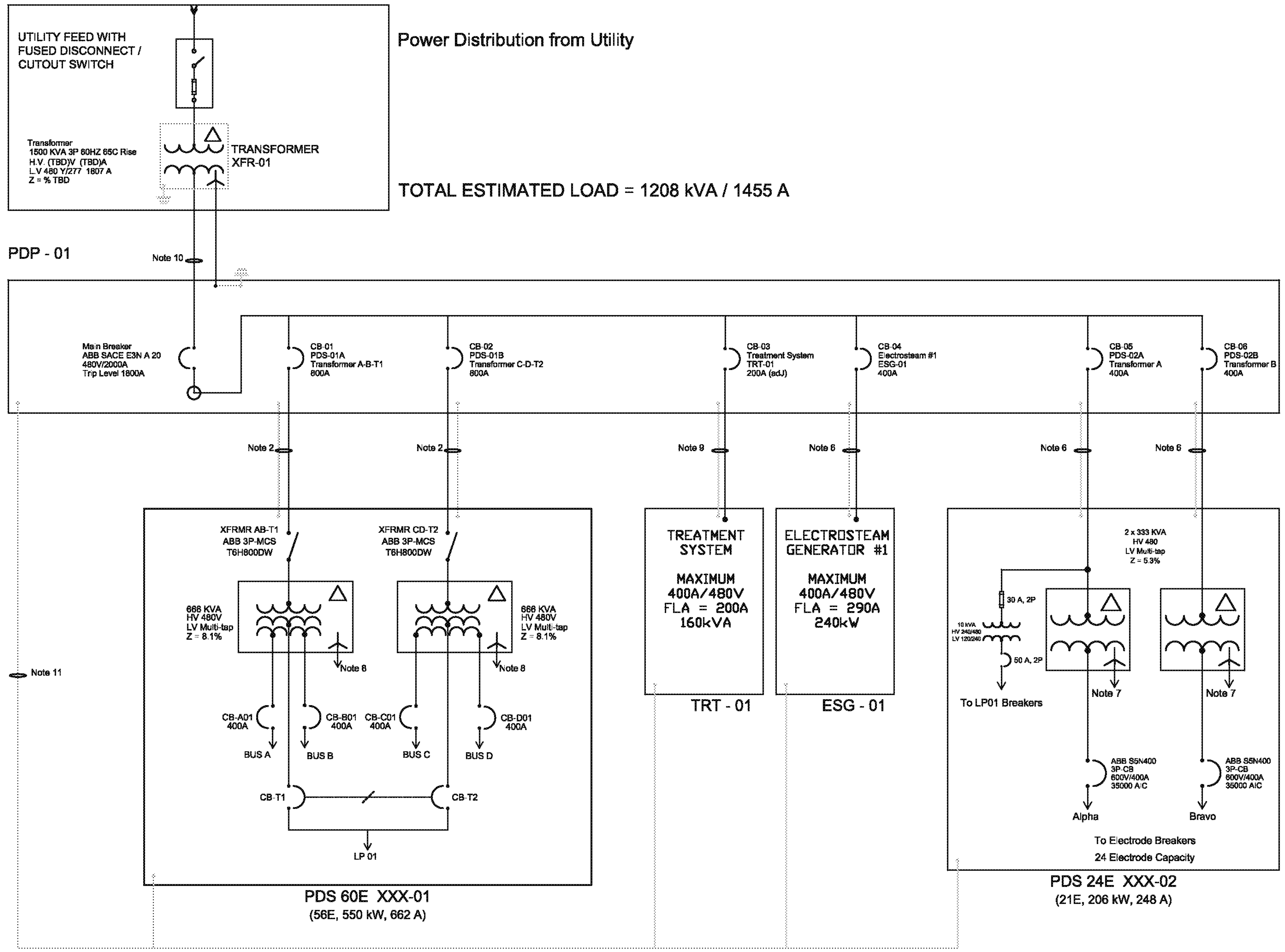
APEGA PERMIT NUMBER: P09178 SCALE: NOT TO SCALE

TITLE: **ET-DSP™ Shallow Well Construction Diagram**
NOT FOR CONSTRUCTION

CLIENT: **Third Site Trust Fund**
Third Site ERH
Zionsville, Indiana

SHEET: **WCD-02**

ED_012957A_00000919-00107



General Notes

1. Construction and material shall comply with applicable Federal, State, local building codes and the NEC Electrical Code.

2. Cable from PDP-01 Breakers CB-01 & CB-02 to PDS 60E XXX-01 Transformer Disconnect Switches AB-T1 and CD-02: Two (2) parallel 3C-350 kcmil c/w #2 AWG AL Ground (STR AL NUAL Alcan Type ACWU90 XLPE INS AIA BLK PVC JKT 600V 90C HL CSA C22.2 NO.51. Above ground rated).

3. Cable from PDS-01 & PDS-02 to each electrode: 1C, No. 1/0 AWG Rockbestos Type DAA1048B EXANE XLPE STR TNC 110C FT4 600V CSA CSA/UL MARINE or equivalent. Above ground rated.

4. ET-DSP™ neutral cable: 1C, No. 1/0 AWG Rockbestos Type DAA1048B EXANE XLPE STR TNC 110C FT4 600V CSA CSA/UL MARINE or equivalent. Above ground rated.

5. Maximum operating load for ET-DSP™ (77 electrodes) is 756 kW.

6. Cable from PDP-01 Breaker CB-04 to Electrosteam Generator ESG-01 and from PDP-01 Breakers CB-05 & CB-06 to PDS 24E XXX-02: Two (2) parallel 3C-250 kcmil c/w #2 AWG AL Ground (STR AL NUAL Alcan Type ACWU90 XLPE INS AIA BLK PVC JKT 600V 90C HL CSA C22.2 NO.51. Above ground rated).

7. All electrical equipment shall be grounded in accordance with NEC. Utility grounding to earth shall NOT be placed within 30 ft of electrode wellfield.

8. ET-DSP neutral grounding scheme determined during system commissioning and shall include all metal-constructed extraction wells. Derived from secondary neutral of main PDS transformers and separate from utility ground.

9. Cable from PDP-01 Breaker CB-03 to Treatment System TRT-01: One (1) 3C-250 kcmil c/w #2 AWG AL Ground (STR AL NUAL Alcan Type ACWU90 XLPE INS AIA BLK PVC JKT 600V 90C HL CSA C22.2 NO.51. Above ground rated).

10. Cable from 1500kVA Transformer XFR-01 to Power Distribution Panel PDP-01 main breaker; six (6) parallel sets of conductors where each set is comprised of three 500 kcmil CU conductors and one 4/0 AWG CU conductor.

11. PDP, PDS and WCS skid bases are to be interconnected with a 2/0 ground cable that originates from electrical service ground at PDP.

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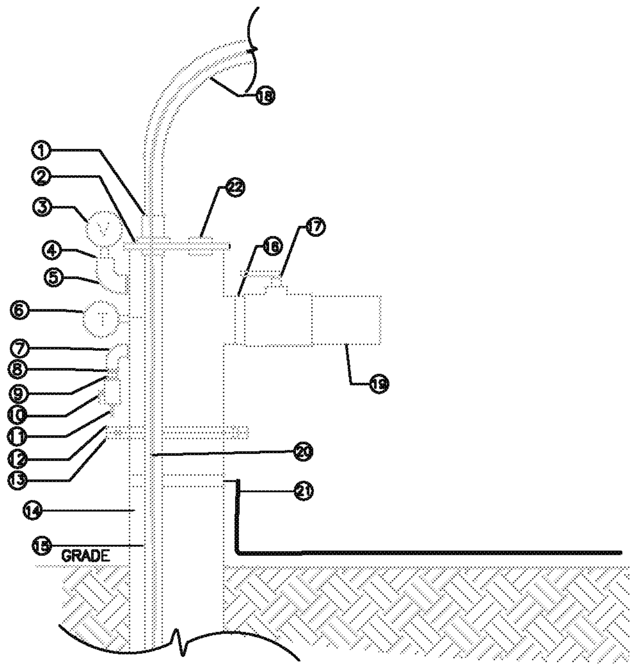
LPE						
	B1	25/05/17	90% DESIGN	DP	EJR	DR
DATE	REV.	DATE (D/M/Yr)	DESCRIPTION	DRAWN BY	ORG/ ENGR	Aproved Dist
	DRAWING NUMBER:			SCALE:	NOT TO SCALE	

TITLE:
ET-DSP Electrical Single Line
NOT FOR CONSTRUCTION

CLIENT:
Third Site Trust Fund
Third Site ERH
Zionsville, Indiana

SHEET:
ESL-01

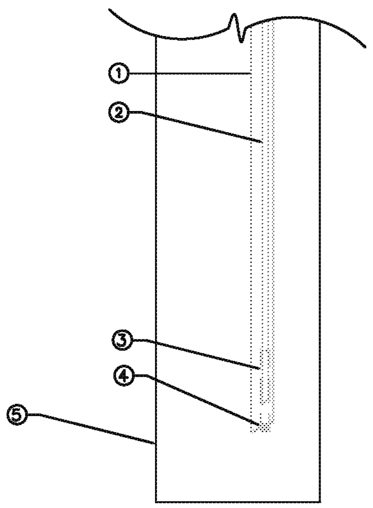
MULTI–PHASE EXTRACTION WELL WITH SLURPER TUBE DETAIL



WELLHEAD COMPONENTS

1. STRAIN RELIEF
2. 4"ø WELL SEAL
3. VACUUM GAUGE 0–30" HG
4. 1/2"M NPT X 1/4"F NPT BUSHING, GALV.
5. 1/2" NPT STREET ELBOW, GALV.
6. TEMPERATURE GAUGE 0–250 F
7. 1/2" NPT STREET ELBOW, GALV.
8. 1/2"M NPT x 3/8"F NPT REDUCER BUSHING, GALV.
9. 3/8" NPT CLOSE NIPPLE, BRASS
10. 3/8" NPT BALL VALVE, BRASS
11. 3/8"M NPT X 1/4" HOSE BARB, BRASS
12. 4"ø STEEL SCH40 FLANGE
13. 4"ø CARBON STEEL BOLT FLANGE
14. 4" NOMINAL I.D. CARBON STEEL WELL CASING
15. 1" I.D. PEX /GW EXTRACTION HOSE
16. 2"ø CLOSE NIPPLE, GALV.
17. 2"ø BALL VALVE, SS.
18. 1" I.D. PEX /GW EXTRACTION HOSE /TO MAINLINE
19. 2"ø NPT PVDF NIPPLE, 12" LONG
20. ¼" I.D. COMPRESSED AIR LINE
21. ET–DSP NEUTRAL WIRE
22. 3/4" NPT SAMPLE PORT PLUG

SLURPER TUBE DETAIL

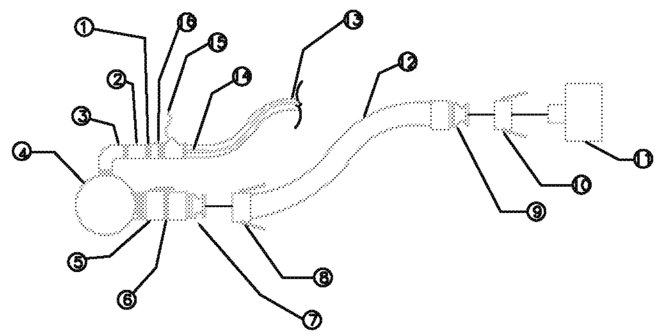


SLURPER TUBE DETAIL COMPONENTS

1. 1" I.D. PEX TUBE CUT ON 45 DEGREE ANGLE
2. ¼" I.D. COMPRESSED AIR LINE CUT ON 45 DEGREE ANGLE
3. 1/2" HDPE INNER TUBE AIRLINE HOUSING
4. 1/2" NPT PLUG, GALV.
5. 4" NOMINAL I.D. SCHED. 40 0.010" SLOTTED CONTINUOUS WIRE WRAP SCREEN

NOTE: Wellhead details are elevation views.

MPE VACUUM EXTRACTION CONNECTIONS

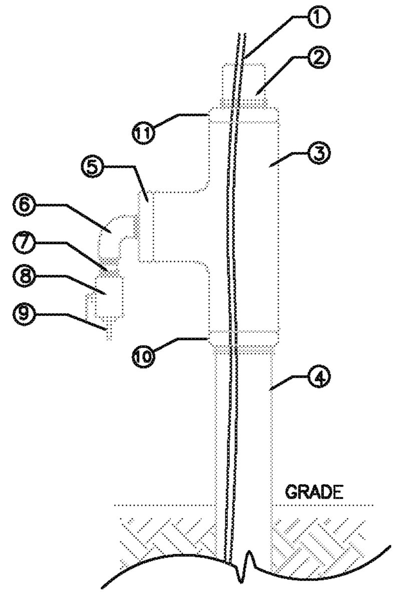


NOTE: 2" MWH Vapor Extraction Hose – Operating Temperatures: –40°F to 200°F (–40°C to 93°C), 150psi pressure rated, chemical, UV rated (Neoprene) / or equivalent.
Wellhead details are elevation views.

WELLHEAD COMPONENTS

1. 1"ø NPT CLOSE NIPPLE, GALV.
2. 1"ø NPT SPRING CHECK VALVE, BRASS
3. 1"ø NPT STREET ELBOW, GALV.
4. MPE EXTRACTION PIPING
5. 2"ø NPT BALL VALVE, GALV.
6. 2"ø NPT CLOSE NIPPLE, GALV.
7. 2"M CAM LOCK X 2"F NPT, AL. ALLOY
8. 2"F CAM LOCK X 2" HOSE BARB, AL. ALLOY
9. 2"M CAM LOCK X 2" HOSE BARB, AL. ALLOY
10. 2"F CAM LOCK X 2"F NPT, AL. ALLOY
11. MPE WELLHEAD
12. 2" VAC HOSE
13. 1" I.D. PEX /GW EXTRACTION HOSE /TO MAINLINE
14. 1"M NPT X 1" PEX BARB
15. ¼" I.D. COMPRESSED AIR LINE
16. 1"ø NPT BALL VALVE, GALV.

digiTAM™ WELLHEAD DETAIL



digiTAM™ WELLHEAD COMPONENTS

1. digiTAM™ SENSOR STRING
2. 1/2" STRAIN RELIEF AND 1"M NPT TO 1/2"F NPT REDUCER BUSHING (ASSEMBLED ON digiTAM)
3. 2"F NPT x 2"F NPT x 2"F NPT TEE, GALV.
4. 1–1/2" CARBON STEEL CASING
5. 2"M NPT x 3/8" F NPT BUSHING, GALV.
6. 3/8" NPT STREET ELBOW, GALV.
7. 3/8" NPT CLOSE NIPPLE, GALV.
8. 3/8" NPT BALL VALVE, BRASS
9. 3/8"M NPT X 1/4" HOSE BARB, BRASS
10. 2"M NPT x 1–1/2"F NPT BUSHING, GALV.
11. 2"M NPT x 1"F NPT BUSHING, GALV.

NOTE: Wellhead details are elevation views.

McMillan-McGee Corp.
Creators of ET-DSP™
McMillan-McGee Corp.
Electromagnetic Systems and Services For the Energy and Environmental Industries
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Ph: 403.569.5100, Fx: 403.272.7201

REV.	DATE (YY/MM/DD)	DESCRIPTION	DRAWN	ORG/ ENGR	APPR/ DIST
B1	2017/05/26	90% DESIGN	ND	EJR	DR

LPE:
DATE:
APEGA PERMIT NO. P09178
SCALE: NOT TO SCALE

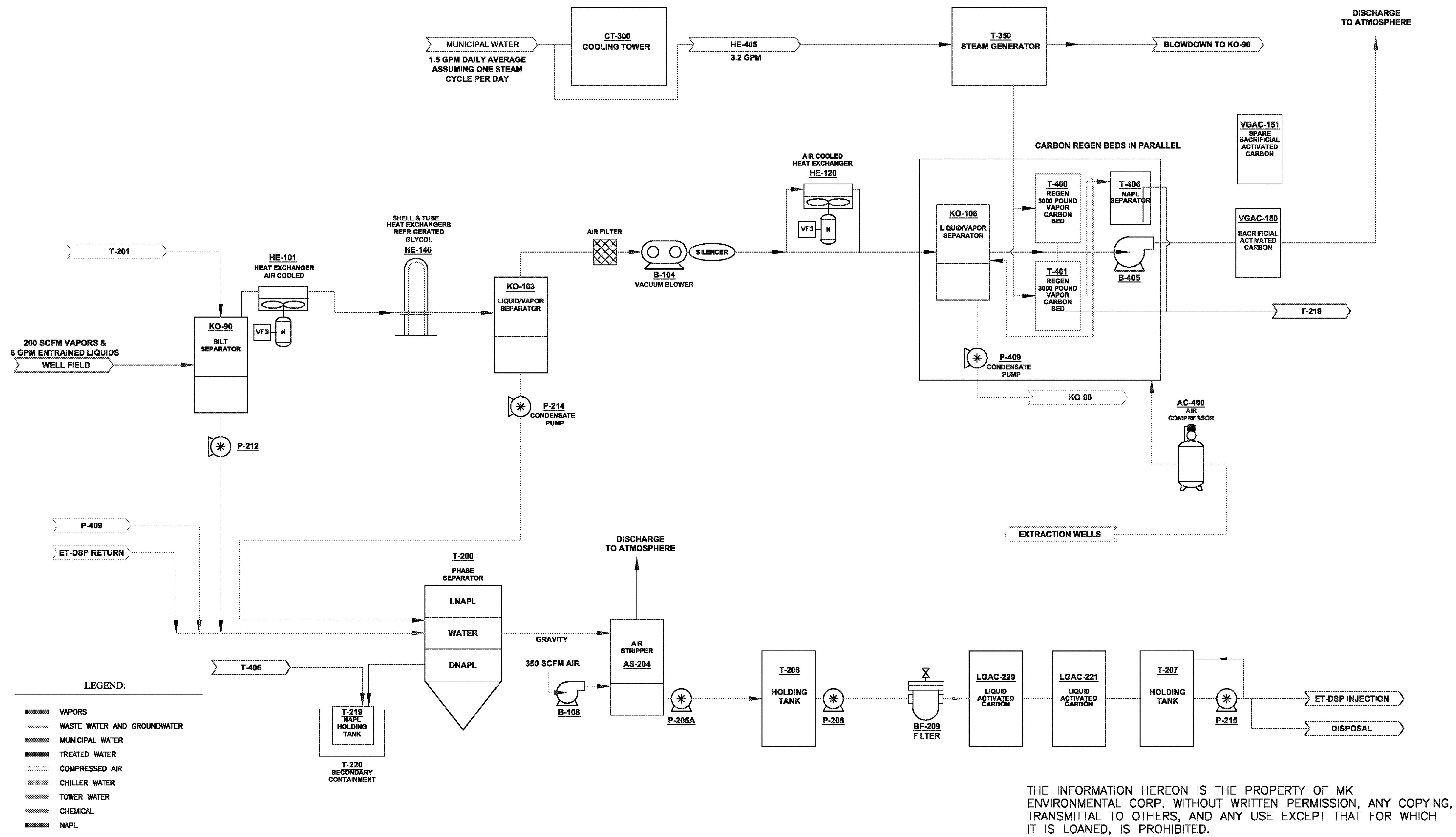
TITLE: **ET-DSP™ Well Head Detail**
NOT FOR CONSTRUCTION

CLIENT: **Third Site Trust Fund**
Third Site ERH
Zionsville, Indiana

SHEET: **WHD-01**

Appendix D – Treatment System Drawings

1. M-1 Process Flow Diagram – Water and Vapor Treatment System
2. M-2 P&ID System Diagram – Vapor Treatment System
3. M-3 P&ID Regen 3000
4. M-4 P&ID System Diagram – Sacrificial Carbon Treatment System
5. M-5 P&ID System Diagram – Groundwater Treatment System
6. M-6 P&ID System Diagram – Water Cooling System
7. M-7 P&ID System Diagram – Steam Heating System
8. M-8 Instrument Legend
9. M-9 Treatment Equipment Layout



SCALE: NONE
DESIGNED: EHT
CHECKED BY: EHT
DRAWN BY: MAL
DRAWN DATE: 01/04/17

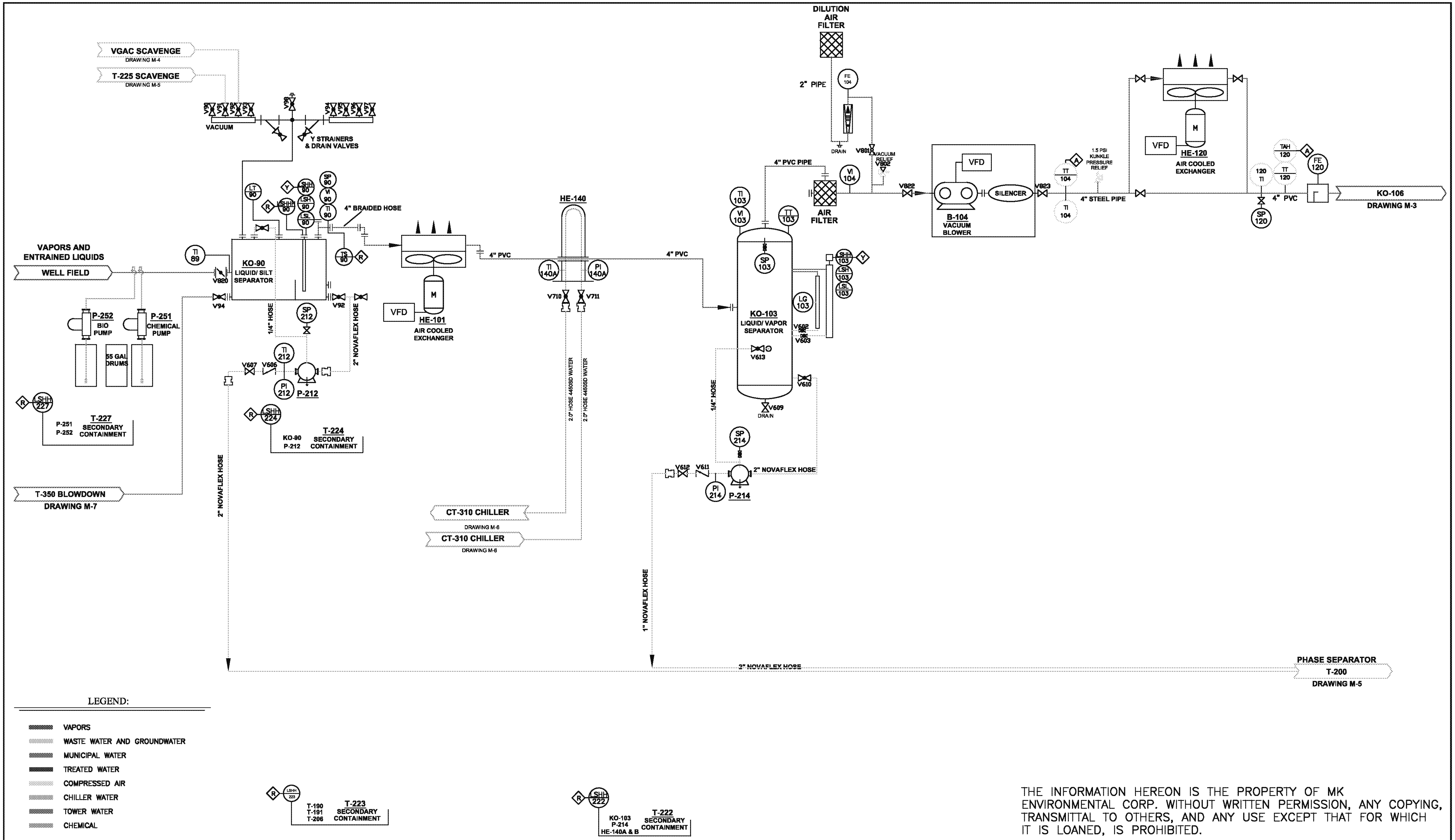
MK ENVIRONMENTAL INC.

PROCESS FLOW DIAGRAM
WATER AND VAPOR
TREATMENT SYSTEM

THIRD SITE TRUST FUND
THIRD SITE ERH
ZIONSVILLE, INDIANA

No.	DATE:	BY:	REVISION:
1			
2			
3			
4			
5			

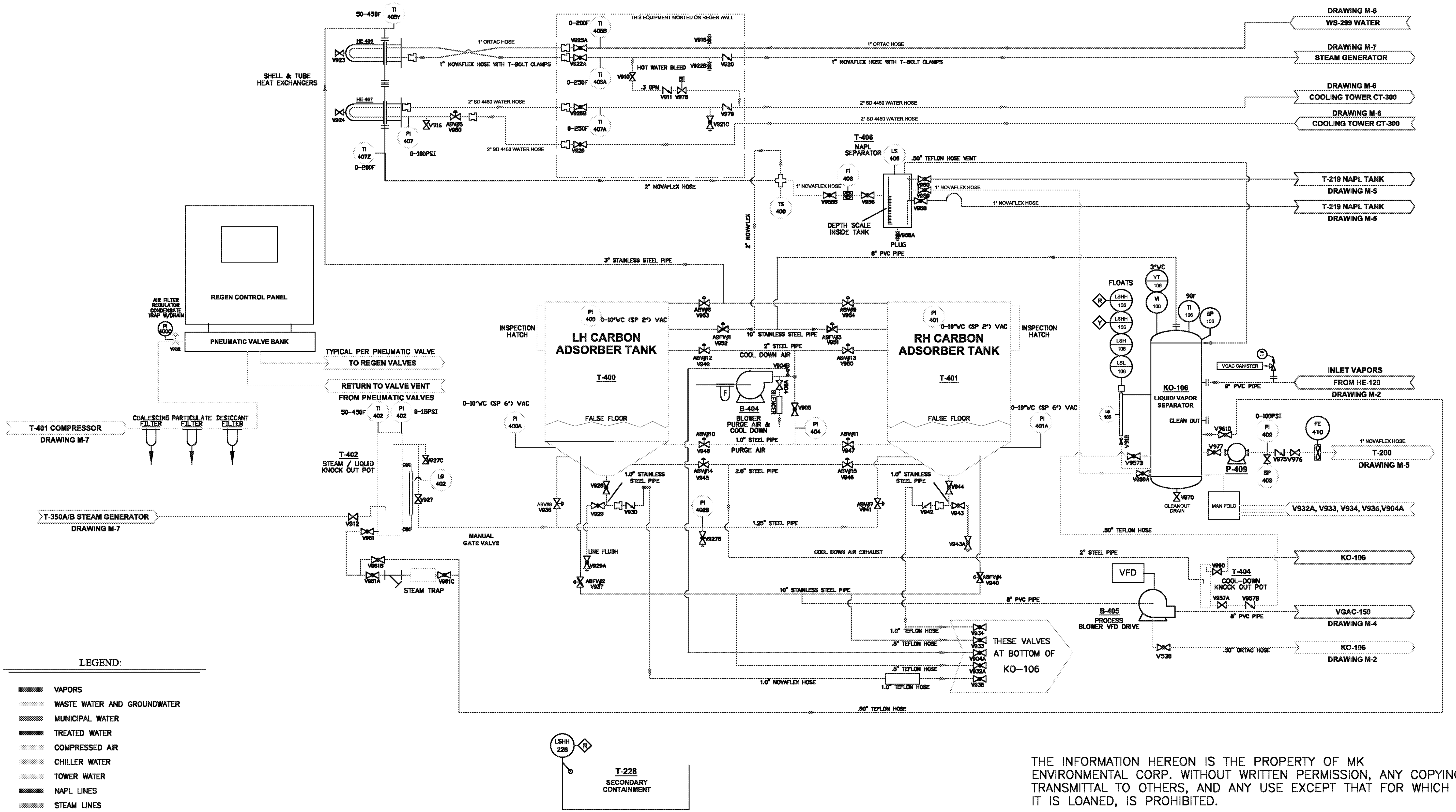
FIGURE NUMBER
M-1



LEGEND:

- VAPORS
- WASTE WATER AND GROUNDWATER
- MUNICIPAL WATER
- TREATED WATER
- COMPRESSED AIR
- CHILLER WATER
- TOWER WATER
- CHEMICAL

SCALE: NONE		MK ENVIRONMENTAL INC.	P&ID SYSTEM DIAGRAM VAPOR TREATMENT SYSTEM	THIRD SITE TRUST FUND THIRD SITE ERH ZIONSVILLE, INDIANA	No.	DATE:	BY:	REVISION:	FIGURE NUMBER M-2
DESIGNED: EHT	CHECKED BY: EHT								
DRAWN BY: ML	DRAWN DATE: 01/4/2017								



SCALE: NONE	
DESIGNED: EHT	CHECKED BY: EHT
DRAWN BY: ML	DRAWN DATE: 01/04/2017

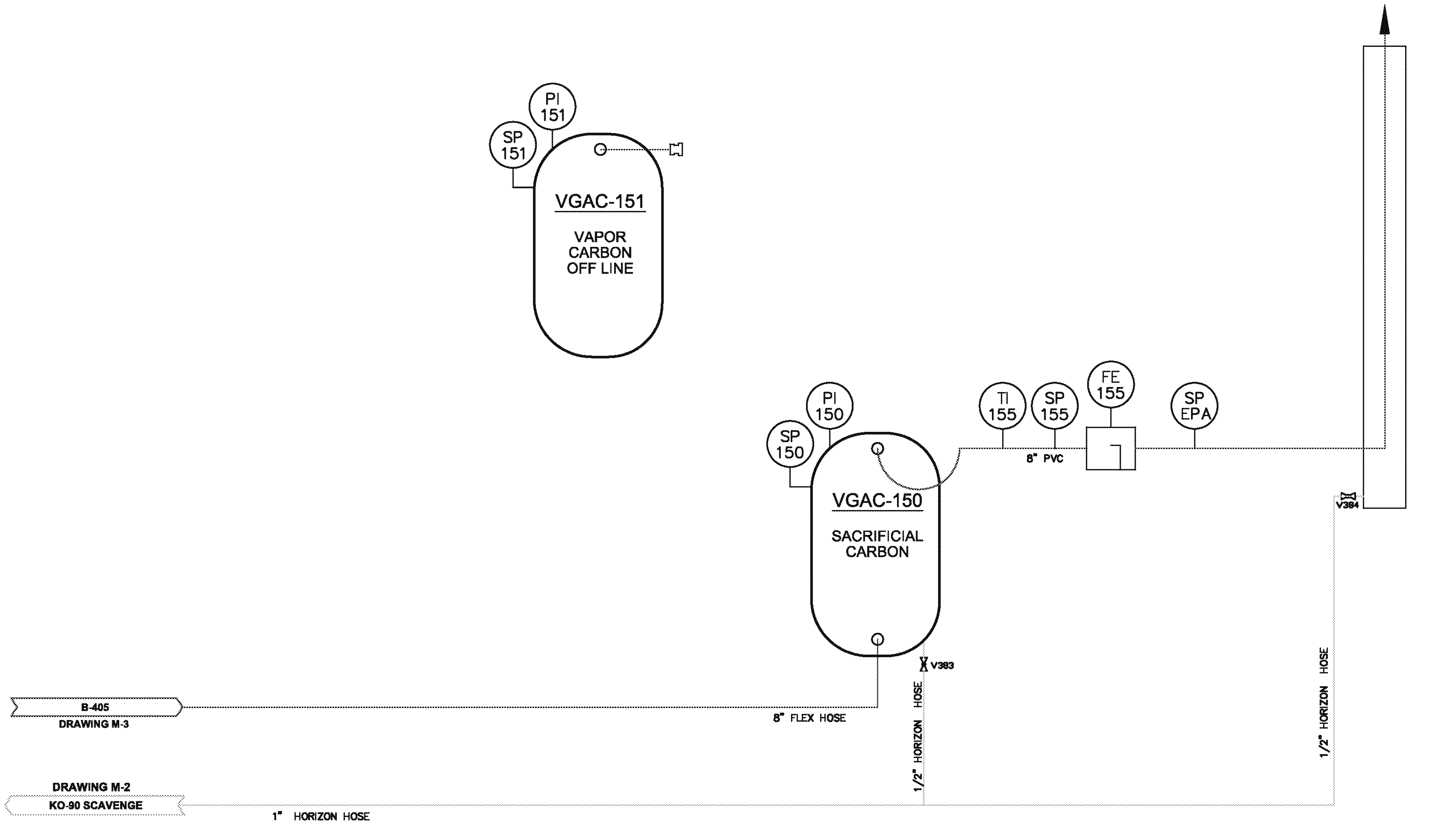
MK ENVIRONMENTAL INC.

P&ID
REGEN

THIRD SITE TRUST FUND
THIRD SITE ERH
ZIONSVILLE, INDIANA

No.	DATE:	BY:	REVISION:
1			

FIGURE NUMBER
M-3



LEGEND:

- VAPORS
- WASTE WATER AND GROUNDWATER
- MUNICIPAL WATER
- TREATED WATER
- COMPRESSED AIR
- CHILLER WATER
- TOWER WATER

SCALE: NONE

DESIGNED:	CHECKED BY:
EHT	EHT
DRAWN BY: ML	DRAWN DATE: 01/4/2017

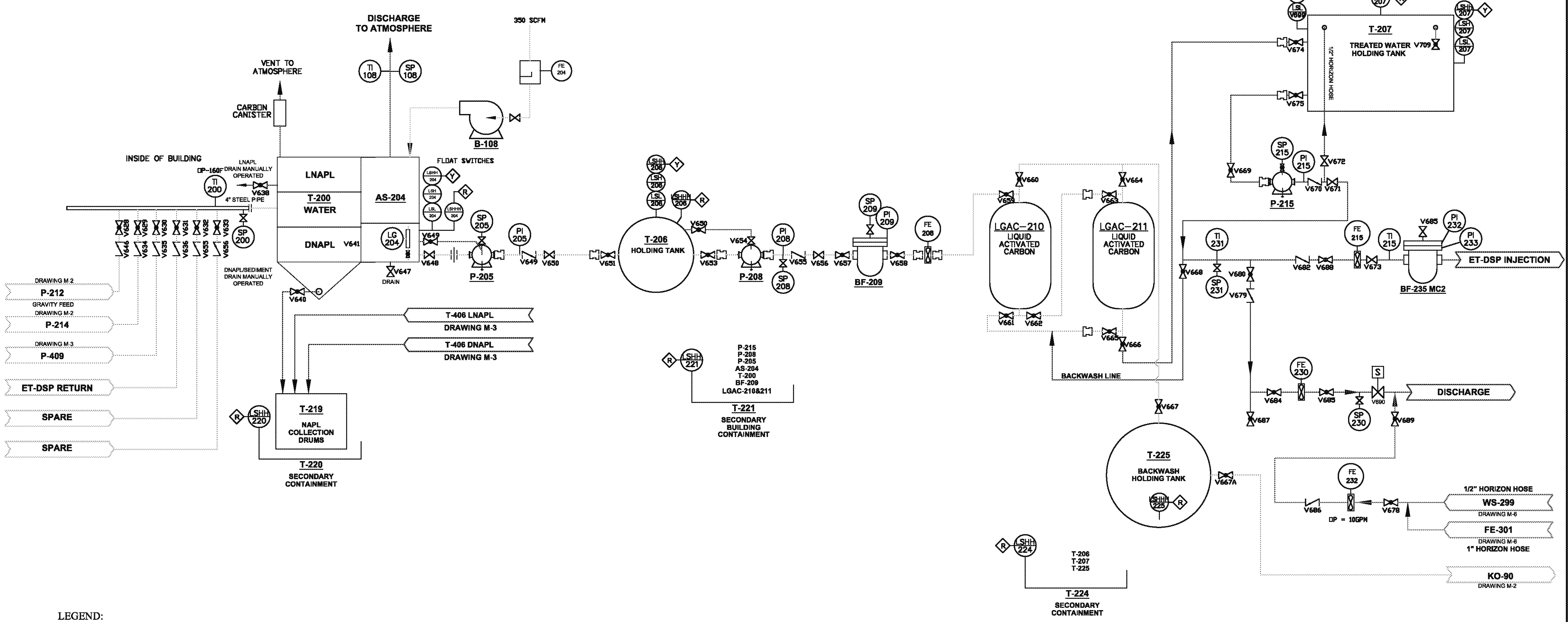
MK ENVIRONMENTAL INC.

P&ID SYSTEM DIAGRAM
SACRIFICIAL CARBON
TREATMENT SYSTEM

THIRD SITE TRUST FUND
THIRD SITE ERH
ZIONSVILLE, INDIANA

No.	DATE:	BY:	REVISION:
1			
2			
3			
4			
5			

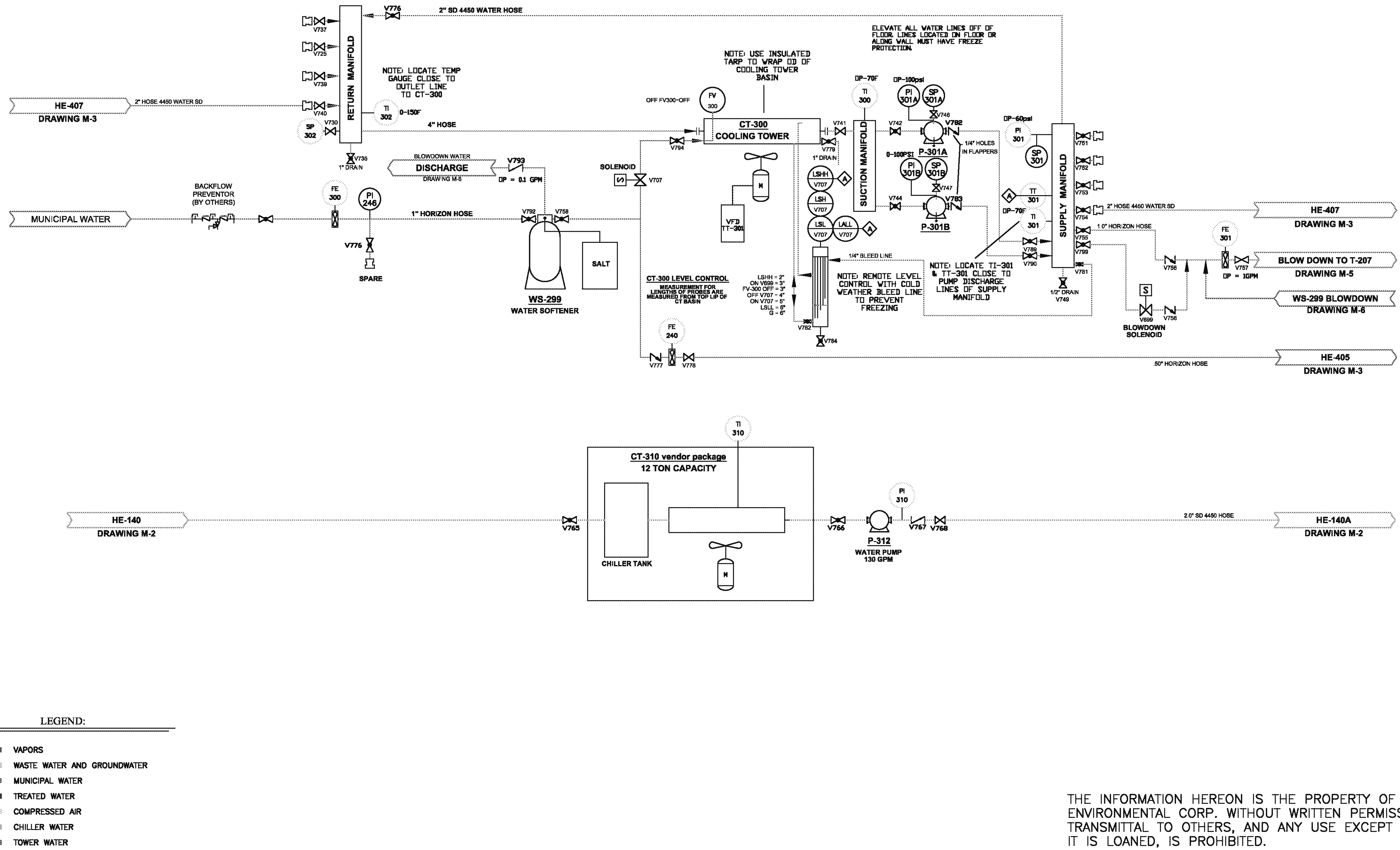
FIGURE NUMBER
M-4



LEGEND:

- VAPORS
- WASTE WATER AND GROUNDWATER
- MUNICIPAL WATER
- TREATED WATER
- COMPRESSED AIR
- CHILLER WATER
- TOWER WATER
- CHEMICAL
- NAPL

SCALE: NONE		MK ENVIRONMENTAL INC.	P&ID SYSTEM DIAGRAM GROUNDWATER TREATMENT SYSTEM	THIRD SITE TRUST FUND THIRD SITE ERH ZIONSVILLE, INDIANA	No.	DATE:	BY:	REVISION:	FIGURE NUMBER M-5
DESIGNED: EHT	CHECKED BY: EHT								
DRAWN BY: ML	DRAWN DATE: 01/04/2017								



SCALE: NONE

DESIGNED: EHT | CHECKED BY: EHT

DRAWN BY: ML | DRAWN DATE: 01/04/2017

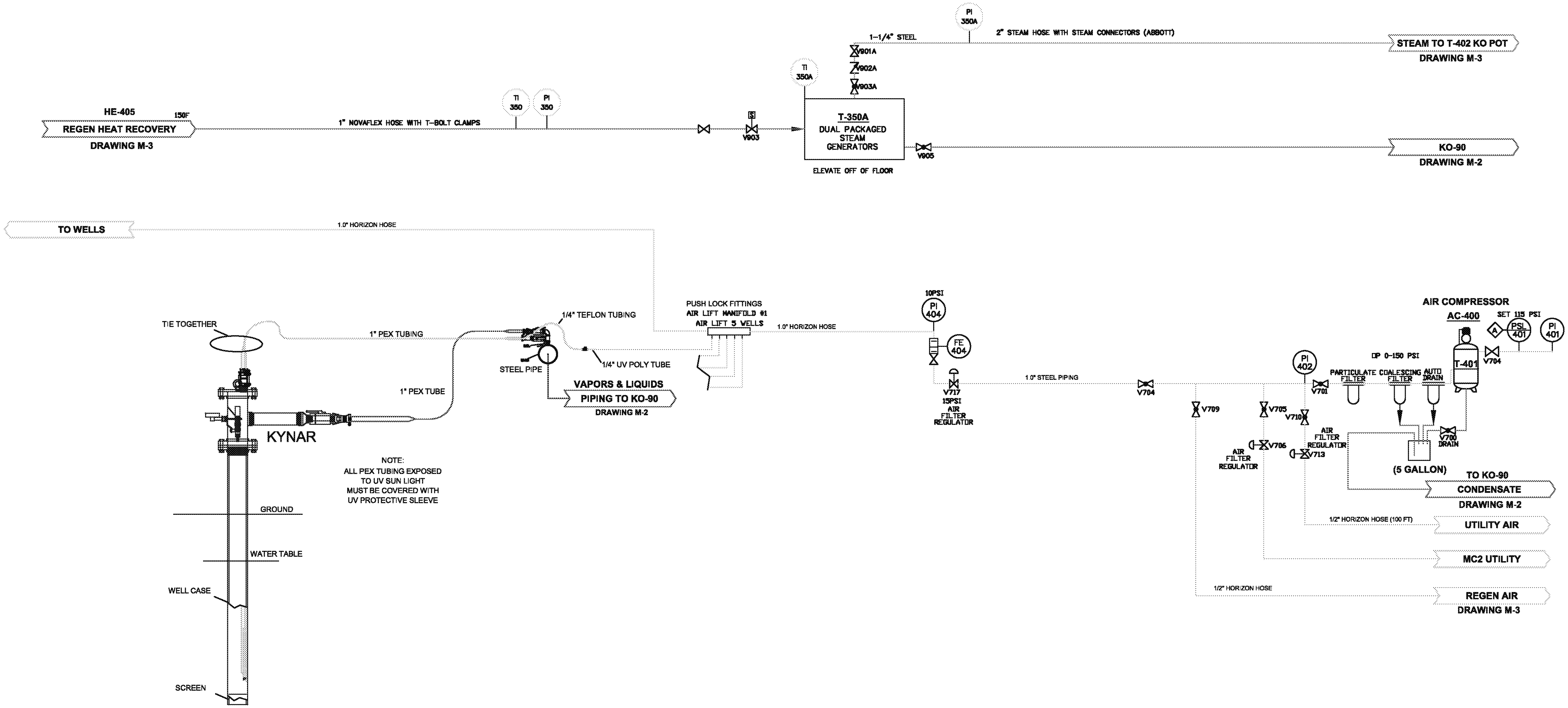
MK ENVIRONMENTAL INC.

P&ID SYSTEM DIAGRAM
WATER COOLING
SYSTEMS

THIRD SITE TRUST FUND
THIRD SITE ERH
ZIONSVILLE, INDIANA

No.	DATE:	BY:	REVISION:

FIGURE NUMBER M-6



LEGEND:

- VAPORS
- WASTE WATER AND GROUNDWATER
- MUNICIPAL WATER
- TREATED WATER
- COMPRESSED AIR
- CHILLER WATER
- TOWER WATER
- NAPL LINES

SCALE: NONE			
DESIGNED: EHT	CHECKED BY: EHT		
DRAWN BY: ML	DRAWN DATE: 01/04/2017		

MK ENVIRONMENTAL INC.

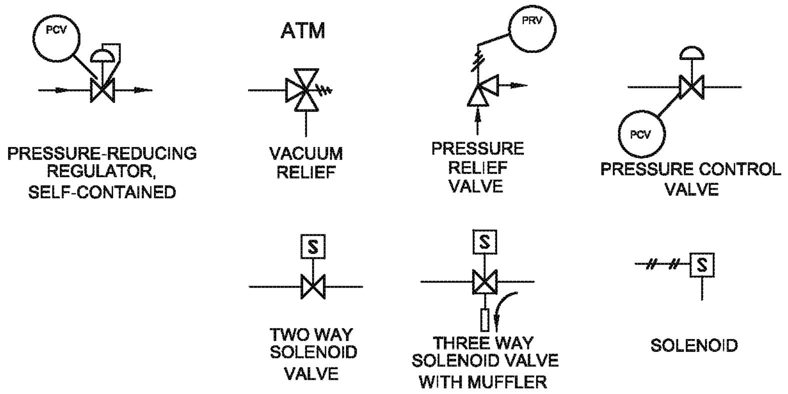
P&ID SYSTEM DIAGRAM
STEAM HEATING SYSTEM
COMPRESSED AIR SYSTEM

THIRD SITE TRUST FUND
THIRD SITE ERH
ZIONSVILLE, INDIANA

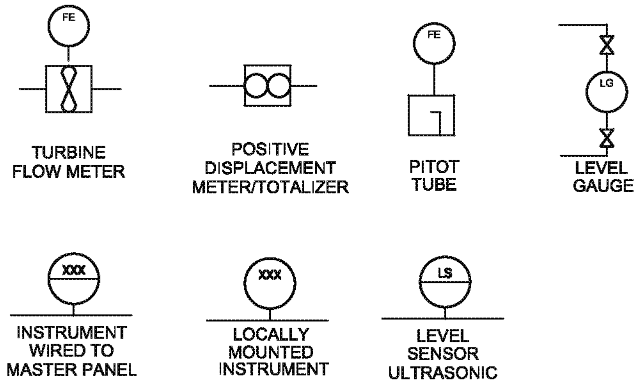
No.	DATE:	BY:	REVISION:

FIGURE NUMBER
M-7

SYMBOLS FOR SELF-ACTUATED REGULATORS, VALVES, AND OTHER DEVICES



MEASUREMENT DEVICES



CONTROL INTERLOCKS

ALARM CONDITIONS

- G GREEN - NO ALARMS OK TO OPERATE
- Y YELLOW - STOPS WATER FLOW FROM WELLS & REDUCES SYSTEM VACUUM
- R RED - IMMEDIATELY SHUTS DOWN ALL OPERATION OF ALL LIQUID AND VAPOR PROCESSING EQUIPMENT
- A ALERT - GIVES A SIGNAL WITHOUT FUNCTION CHANGE

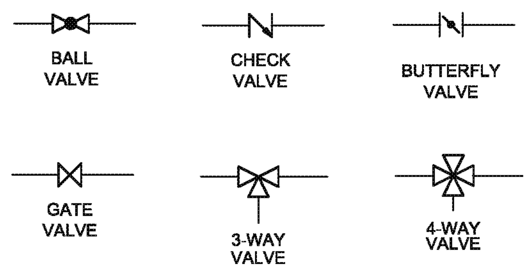
INSTRUMENT ABBREVIATIONS

DPI	DIFFERENTIAL PRESSURE INDICATOR
FE	FLOW ELEMENT
FM	FLOW METER
LAH	LEVEL ALARM HIGH
LAHHH	LEVEL ALARM HIGH-HIGH-HIGH
LAHH	LEVEL ALARM HIGH-HIGH
LAL	LEVEL ALARM LOW
LSH	LEVEL SWITCH HIGH
LSHH	LEVEL SWITCH HIGH-HIGH
LSL	LEVEL SWITCH LOW
LSLL	LEVEL SWITCH LOW LOW
LT	LEVEL TRANSMITTER
PI	PRESSURE INDICATOR
PT	PRESSURE TRANSMITTOR
PVR	PRESSURE VACUUM RELIEF
TI	TEMPERATURE INDICATOR
TIT	TEMPERATURE INDICATING TRANSMITTER
TS	TEMPERATURE SWITCH
VAH	VACUUM ALARM HIGH
VI	VACUUM INDICATOR
VS	VACUUMSWITCH
VSH	VACUUM SWITCH HIGH
VT	VACUUM TRANSMITTER
TAH	TEMPERATURE ALARM HIGH
TT	TEMPERATURE TRANSMITTER
LG	LEVEL GAUGE

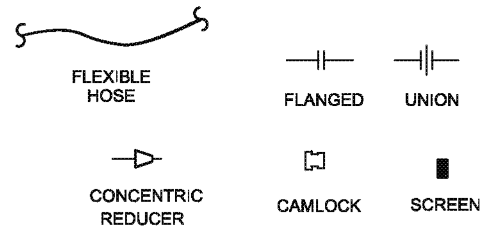
TERMS AND ABBREVIATIONS

AC	AIR COMPRESSOR
AS	AIR STRIPPER
ATM	ATMOSPHERE
B	BLOWER
BF	BAG FILTER
CF	CARTRIDGE FILTER
CT	COOLING TOWER OR CHILLER
DNAPL	DENSE NON AQUEOUS PHASE LIQUIDS
ESD	EMERGENCEY SHUT DOWN
HE	HEAT EXCHANGER
HOA	HAND/OFF/AUTO
KMNO4	POTASSIUM PERMANGANATE
KO	LIQUID / VAPOR / SILT SEPARATOR
LGAC	LIQUID-PHASE GRANULAR ACTIVATED CARBON
LNAPL	LIGHT NON-AQUEOUS PHASE LIQUIDS
LH	LEFT HAND
M	MOTOR
NAPL	NON-AQUEOUS PHASE LIQUIDS
NC	NORMALLY CLOSED
OC	ORGANIC CLAY
P	PUMP
T	HOLDING TANK, STEAM GENERATOR TANK
RH	RIGHT HAND
V	VALVE
VFD	VARIABLE FREQUENCY DRIVE
VGAC	VAPOR-PHASE GRANULAR ACTIVATED CARBON
FRP	FIBERGLASS REINFORCED PIPE
MOV	MOTOR OPERATED VALVE
SP	SAMPLE PORT
ET-DSP	ELECTROTHERMAL DYNAMIC STRIPPING PROCESS
S	SOLENOID VALVE
WS	WATER SOFTENER
ATM	ATMOSPHERE
PEX	PEX
UV	ULTRA VIOLET

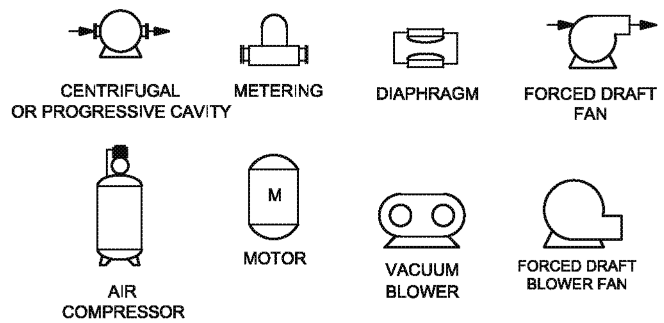
VALVES



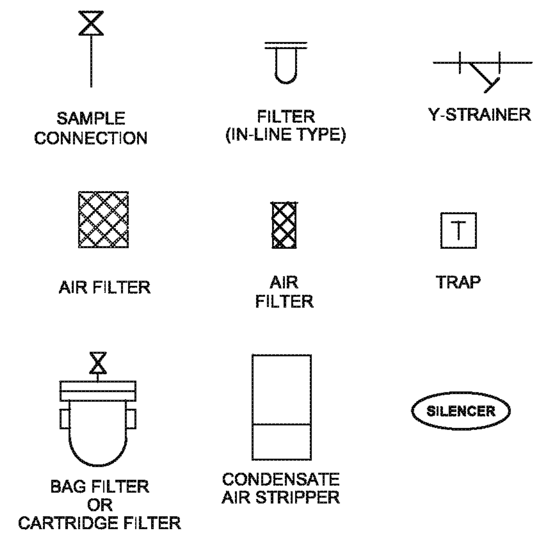
PIPING AND PIPING CONNECTIONS



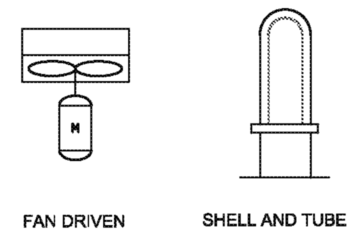
PUMPS & MOTORS



MISCELLANEOUS



HEAT EXCHANGERS



SCALE: NONE

DESIGNED: EHT | CHECKED BY: EHT

DRAWN BY: ML | DRAWN DATE: 01/04/2017

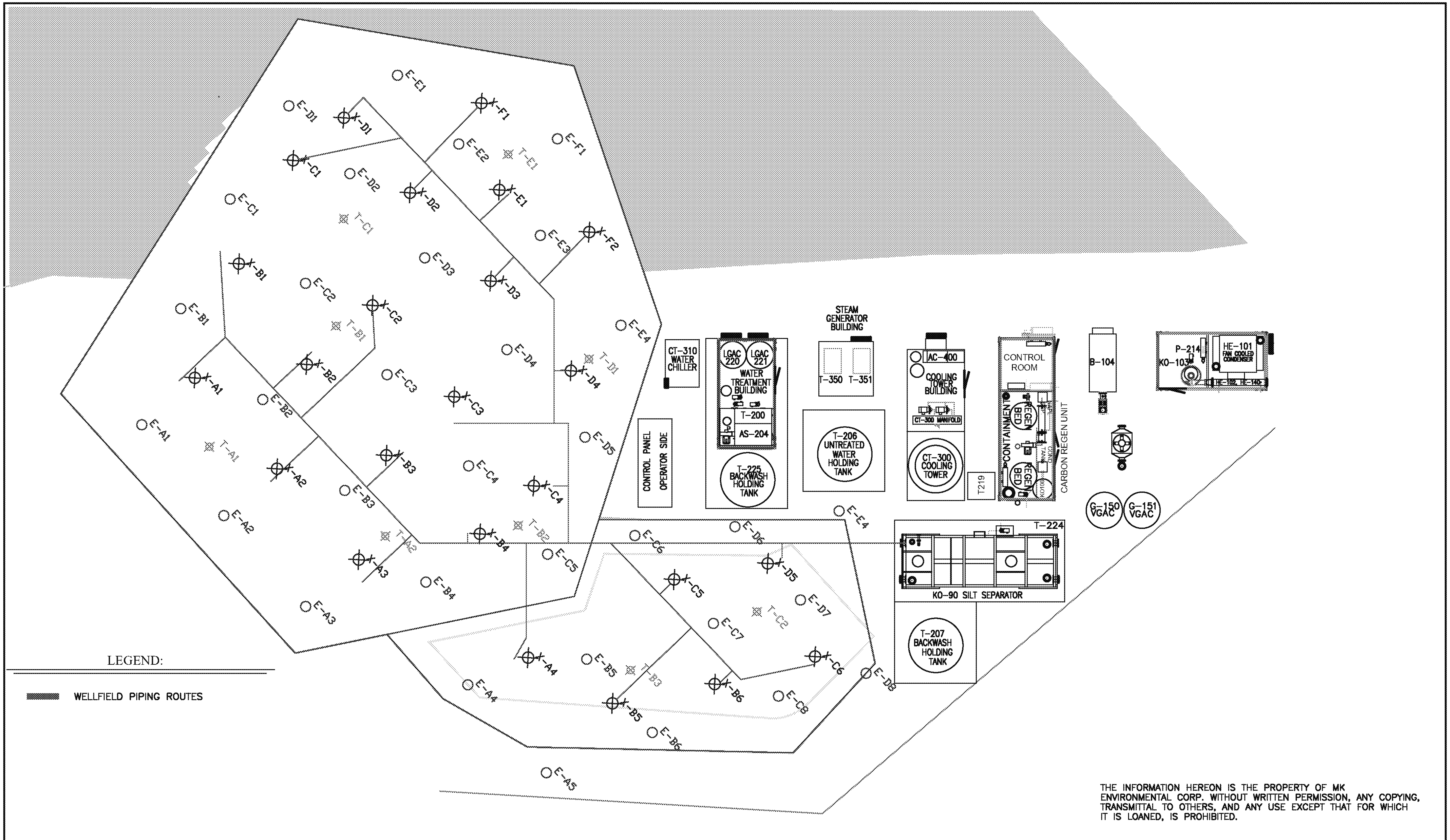
MK ENVIRONMENTAL INC.

GENERAL INSTRUMENT LEGEND

THIRD SITE TRUST FUND
THIRD SITE ERH
ZIONSVILLE, INDIANA

No.	DATE:	BY:	REVISION:

FIGURE NUMBER M-8



SCALE: Not to Scale	
DESIGNED: MAL	CHECKED BY: EHT
DRAWN BY: MAL	DRAWN DATE: 05/25/17

MK ENVIRONMENTAL INC.

THIRD SITE TRUST FUND
THIRD SITE ERH
ZIONSVILLE, INDIANA
EQUIPMENT & WELLFIELD LAYOUT

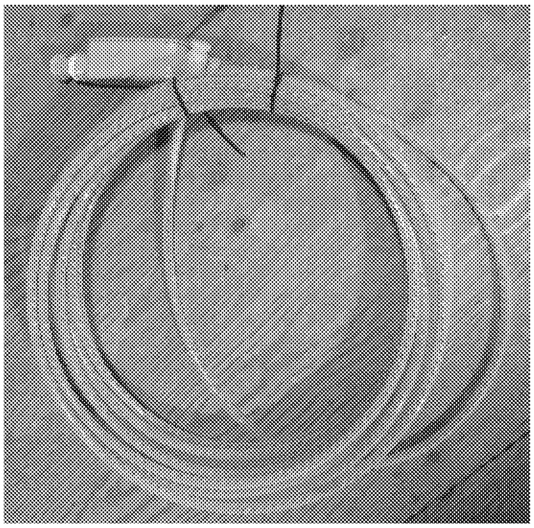
No.	DATE:	BY:	REVISION:
B1	01/14/17	MAL	PRELIMINARY WELLFIELD LAYOUT
B2	03/08/17	MAL	DRAWING FORMAT REVISION
B3	05/25/17	MAL	UPDATE FOR ERH WELLFIELD

FIGURE NUMBER
M-9

Appendix E – Equipment Cut Sheets

1. DigiTAM™ sensor
2. 24 Electrode Power Delivery System
3. 24 Electrode Water Circulation System
4. 60 Electrode Power Delivery System
5. 60 Electrode Water Circulation System

McMillan McGee Corp.
digiTAM Temperature Acquisition Module



digiTAM
Sensor String Specifications

Temperature	Principle	Integrated silicon temperature sensors
	Range	-55 to 125°C
	Accuracy	±0.5 °C
	Resolution	±0.125 °C
Environmental	Media compatibility	Air, water, steam, fuels, oils (Contact Mc² for specific contaminants)
	Wetted material	Teflon
Dimensions	Bottom Seal	1-1/16" (max)
	Cable	1/2 "
	Sensor interval (typ)	3.0 ft
Weight	Cable	50g/ft.
Connection	Power	External supply, 3.0 to 5.5 V DC; no batteries needed Power consumption of 7.5 mW per sensor during measurement
	Communication	Data acquisition occurs using Mc²'s 3 line digital serial bus Individual temperature measurements occur within 750 ms Data immediately accessible via the internet
	Sensor string	Placed in a drop-tube at required depth and anchored to surface
	Data server	Data lines connected with CAT5 cable Connects to site server through Mc² communication hub

Networking
Multiple digiTAMs are accessed from a data server using Mc²'s communication protocols. Temperatures are immediately accessible via the Internet.

Easily Powered
DigiPAMs require only 7.5 mW of power per sensor during temperature conversions. External power supply over the 3 line digital bus means no batteries are required.

Digital at the Source
The temperatures are converted directly to digital signals to limit the effects of high electromagnetic interference due to thermal remediation systems. DigiTAMs and digiPAM pressure sensors are connected on the same digital bus for simple installation, automated process monitoring and real-time data access.

Instantaneous Temperature Profiling
The digiTAM strings make use of multiple temperature sensors on a common 3 line digital bus. Typically 30 temperature sensors are embedded in the Santoprene cable at 2.5 ft intervals. Thus a complete temperature profile is obtained for a narrow borehole within seconds.

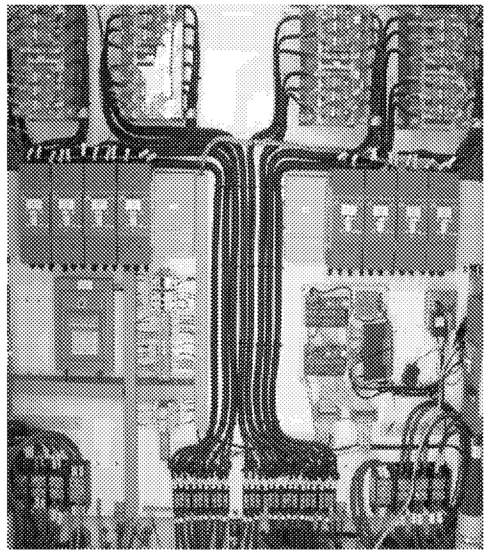
Extreme Environments
DigiTAMs are fully submersible and measure temperatures of up to 125°C. The sensor is compatible with most chemical contaminants seen at remediation sites.

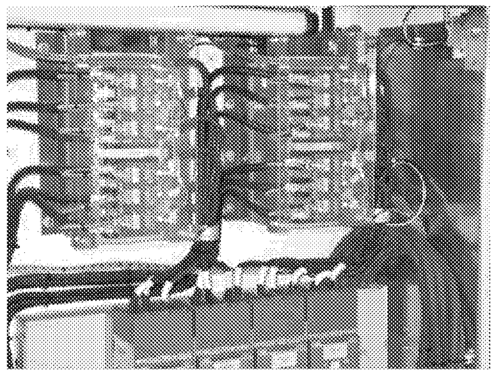
Fast Installation
DigiTAMs are simply lowered into a monitoring well and anchored to the surface. The sensor is linked to the data server using standard CAT5 network cable and Mc²'s communication.

McMillan-McGee Corp.
4895 35B. St. SE. Calgary, Ab. Canada. T2B 3M9
www.mcmillan-mcgee.com

McMillan-McGee Corp.

Creators of ET-DSP™





ET-DSP™ Power Delivery System. 24 Electrode Unit Specifications

Electrical Performance	Principle	Two 3-phase high voltage utility transformers
	Power Rating	2-330 kVA Transformers
	Amperage	2-12 Electrode Busses at 400A Per Phase
		100 A per electrode. 4 Electrodes/Phase/Buss
	Voltage	Multi-tap secondary, 600 V max. phase to phase
		Field adjustable tap settings
Power Control	Principle	Time distributed control - Half-wave AC switching rectifiers
		SCR triggering-electronics with internet capability
	Power Selection	Current duty cycle from off to 100%
		Adjustment increment to 5%
Power Monitoring	Principle	High performance current transducers
		Internet-enabled, full wave CT monitoring electronics
	Measurement	Current amplitude; rms and effective values
		Independent TDCM duty cycle verification

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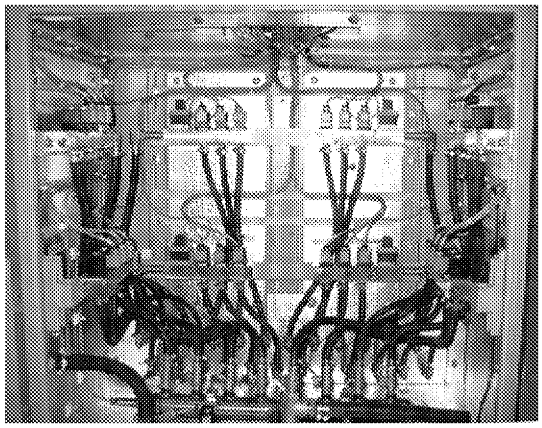
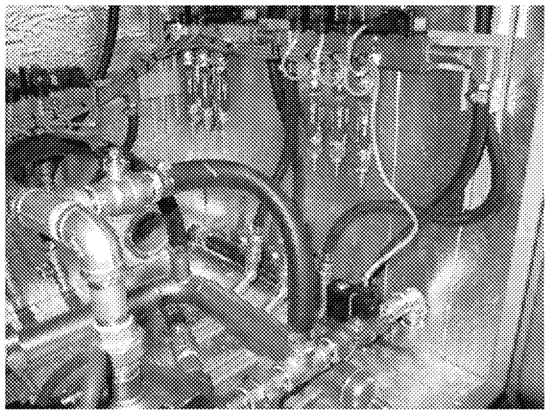
www.mcmillan-mcgee.com





Water Circulation System 24 Electrode Unit Specifications		
Flow Performance	Principle	Utility water supply with internal pump Individual electrode injection valves
	Pressure	Rated at 100 psi
	Temperature	Water at 90ºC
Injection Control	Principle	One voltage fired solenoid valve per electrode Electronic Relay
	Operation	Designed for simultaneous injection to 8 electrodes
Injection Monitoring	Principle	Inline paddle turbine flow meters Internet-enabled pulse counting electronics
	Operation	One flow meter per solenoid valve assembly Each meter monitors injection to 3 electrodes

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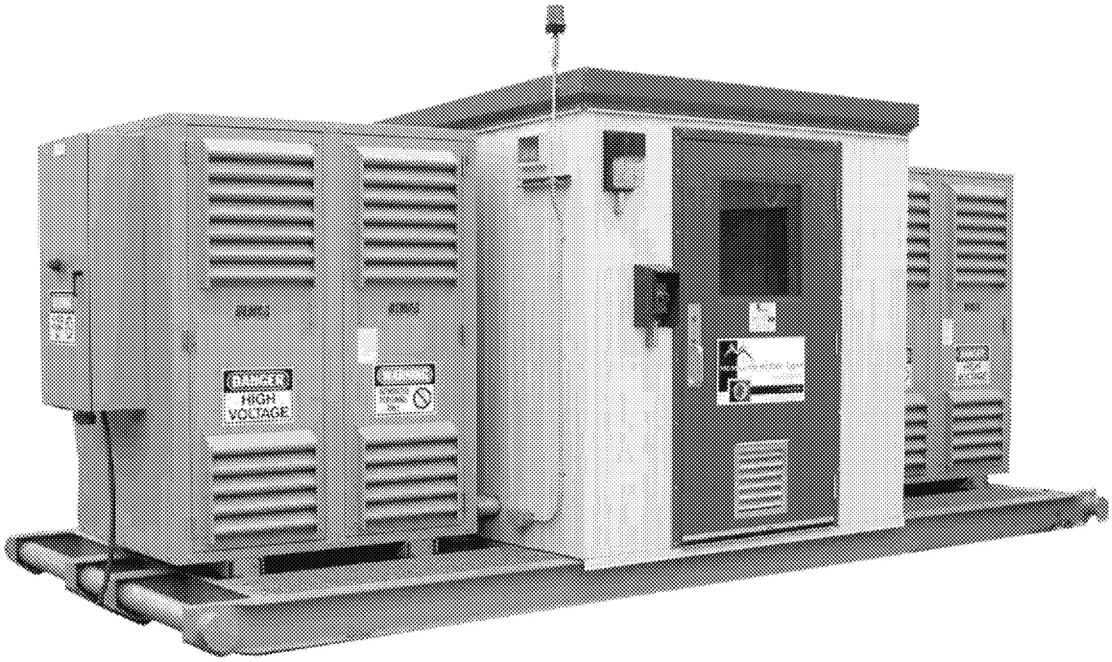
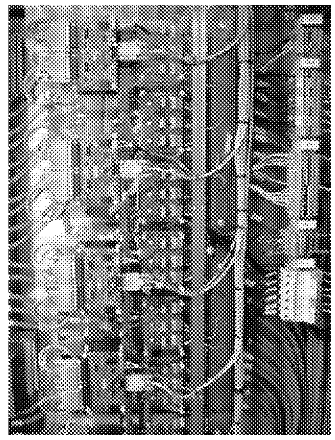
www.mcmillan-mcgee.com

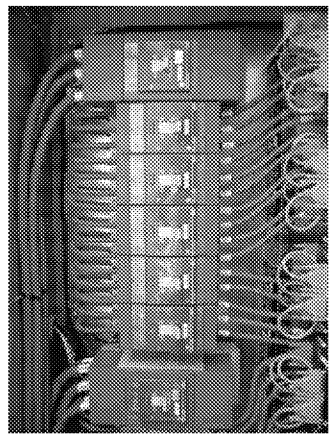
McMillan-McGee Corp.
60 Electrode Power Delivery System (PDS)

McMillan-McGee Corp.

Creators of ET-DSP™







ET-DSP™ Power Delivery System. 60 Electrode Unit Specifications

Electrical Performance	Principle	Two 3-phase high voltage utility transformers
	Power Rating	1330 kVA - 2-660 kVA Transformers
	Amperage	4-15 Electrode Busses at 400A Per Phase
		100 A per electrode. 5 Electrodes/Phase/Buss
	Voltage	Multi-tap secondary, 600 V max. phase to phase
		Field adjustable tap settings
Power Control	Principle	Time distributed control - Half-wave AC switching rectifiers SCR triggering-electronics with internet capability
	Power Selection	Current duty cycle from off to 100% Adjustment increment to 5%
Power Monitoring	Principle	High performance current transducers Internet-enabled, full wave CT monitoring electronics
	Measurement	Current amplitude; rms and effective values Independent TDCM duty cycle verification

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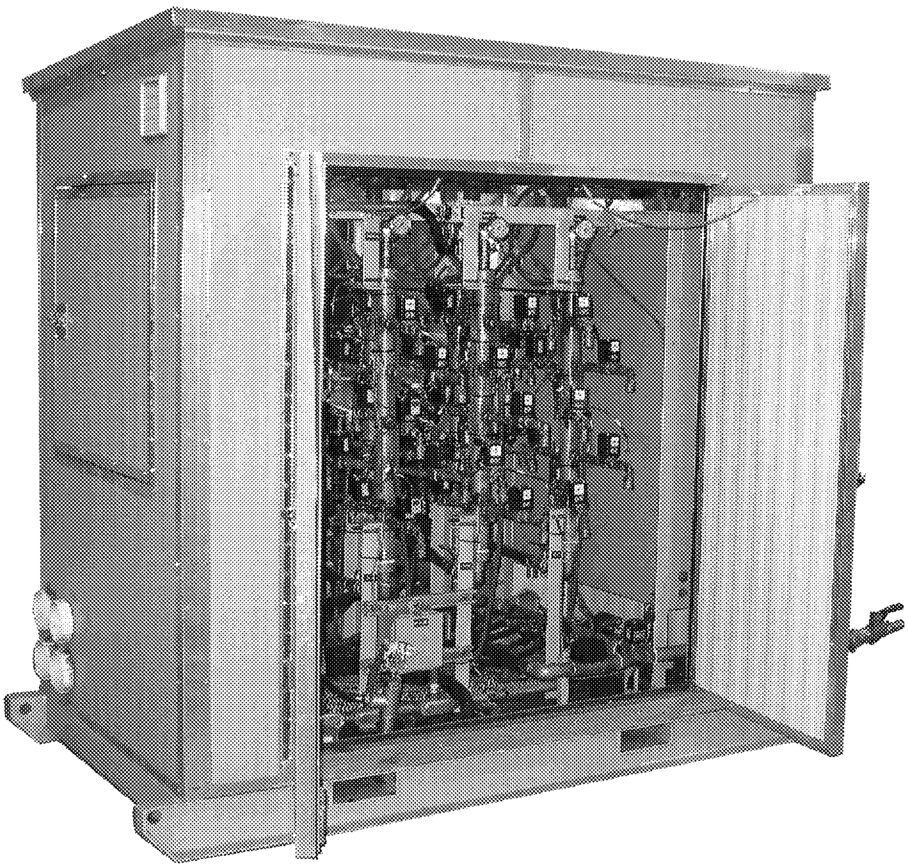
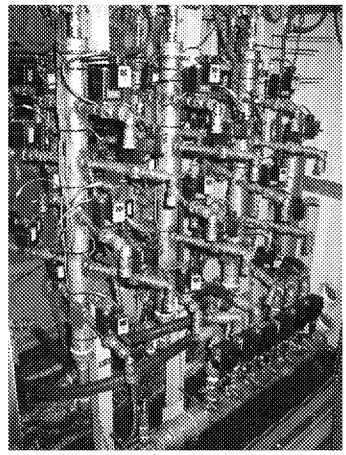
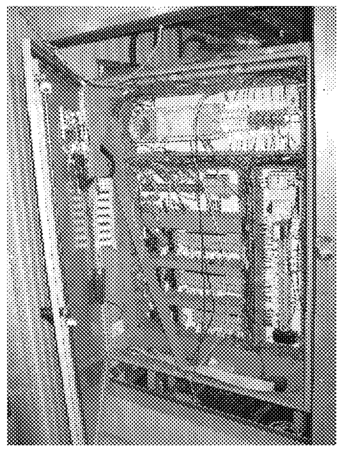
McMillan-McGee Corp.

Creators of ET-DSP™

McMillan-McGee Corp.
60 Electrode Water Circulation System







Water Circulation System 60 Electrode Unit Specifications		
Flow Performance	Principle	Utility water supply with internal pump Individual electrode injection valves
	Pressure	Rated at 100 psi
	Temperature	Water at 90°C
Injection Control	Principle	One voltage fired solenoid valve per electrode Proportional Valve 0-100%
	Operation	Designed for simultaneous injection to 6 electrodes
Injection Monitoring	Principle	Inline ultrasonic flow meters Internet-enabled pulse counting electronics
	Operation	One flow meter per solenoid valve assembly Each meter monitors injection to 10 electrodes

McMillan-McGee Corp.
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www.mcmillan-mcgee.com

Appendix F – Safety Data Sheets

1. AN-310FG Sequestering Agent
2. KCl Electrical Conductivity Agent

1. CHEMICAL IDENTIFICATION

Product Name AN-31OFG
Recommended Use.................... . .. . .Water Treatment Antiscalen t, Descale r
Restrictions on Use..................... . . .. .Not Determined
Emergency Number .... In fotrac 1-800-535-5053
Customer Service Hotline........... . . ..281-28 6-7562 (8 AM to 5 PM CST)

Supplie r of SDS:

Analytix Technologies LLC
PO Box 590466
Houston TX 77259-0466
Tel: (281) 286-7562
Web: www.analytixtechnoloie s.com
Email: analytix@earthlink.net

2. HAZARD IDENTIFICATION

GHS Hazard Classification:

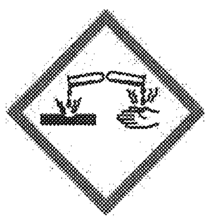
• Skin Irritation	Category 2
• Serious eye damage / irritat ion	Category 1
• Acute Toxicity - Oral	Category 5

GHS Label Elements:

Potential Health Effects - Direct eye contact can cause eye bums. The product is s ligh tly irritating to skin, and irritating to respiratory and gastrointestinal memb ranes.

Label Elements:

- H31 5 Causes skin irritation.
- H31 8 Causes serious eye damage .
- H303 May be harmful if swallowed.




Signal Word: **DANGER**

Prevention:

- P260 Do not inha le dusts/fume/gas/m ist /vapors /spray.
- P264 Wash tho roughly after ha ndl ing.
- P280 Wear protective gloves / eye protection / face protection.

Response:

- P301+P330+P33 1 IF SWALLOWED: Rinse mouth. DO NOT indu c e vom it in g.
- P302+352 IF ON SKIN: Wash with plenty of soap and water.
- P305+351+338 IF IN EYES: Rinse continuously with water for several minutes . Remove contact le nse s if present and easy to do - continue rinsing.
- P3 IO I mmedi a tely call a POISON CENTER or doctor / physic ian.
- P32 l Specific treatment (see informatio n o n this la bel).
- P362 Take off contaminate d clothin g a nd wash before reuse.

Storage: Store lo cked up.

Disposal: Dispose of contents / conta iner in accordance with loca l / regional / national / internatio na l regulations.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Mixture of water treatment chemicals

Chemical Name	CAS No.	GHS Classification
Sodium Polycarboxy late	Not Hazardous	None
1-Hyd roxyethy lidene-1 ,1-diphosphonic	2809-21-4	Eye Damage 1, Skin 2, Oral 5
acid Wat er	7732-18-5	None

Specific chemical identity and/or percentages of composition ha ve been withheld as a trade

4. FIRST AID MEASURES

Eyes ....Immediately flush with water for at least 15 m inute s, lifting the upper and lower
.... eyelids intermittently. See a medical doctor or ophthalmologist imm ediately .

Skin..............................Immediate first aid is not likely to be required. Wash with plenty of soap and water.
.....................................Get medical attention if irritation occurs and pers ists.

Ingestion ....Immediate first aid is not likely to be required . Rinse mouth with water. Dilute by
.....................................giving 2 glasses of water. Do not induce vom itin g. Never give anything by
.....................................mouth to an unconscious person. A physician can be contacted for advice.

Inhalation ....Immediate first aid is not likely to be requir ed. Remove to fresh air. If breathing
.....................................difficulty or discomfort occurs and persists, contact a medical doctor.

NOTES TO MEDICAL DOCTOR: The product is corrosive to the eyes and is expected to be irritating to the mucous membranes of the respiratory and gastrointestinal tracts. Treatment is controlled removal of exposure with symptomatic and supportive care.

5. FIRE FIGHTING MEASURES

SUITABLE EXTINGUISHING MEDIA : alcohol resistant foam, CO_2, powder, water spray

UNSUITABLE EXTINGUISHING MEDIA: Water jet

SPECIAL FIRE FIGHTING PROCEDURES Wear self-contained breathing apparatus with a full face piece operated in the positive pressure demand mode when fighting fires.

HAZARDOUS DECOMPOSITION: CO, CO_2, P_2O_5, phosphines

ERG Guide No. 153

6. ACCIDENT AL RELEASE MEASURES

PROTECTIVE PRECAUTIONS AND EMERGENCY PROCEDURES Keep unnecessary personnel awa y.
Wear appropriate protective equipment and clothing during clean-up. Do not breather mist or vapors. Ensure adequate ventilation

CONTAINMENT PROCEDURE Prevent further leakage or spillage if safe to do so. Contain spills to prevent migration and entry into waterway.

CLEANUP PROCEDURE Contain large spills with dikes and transfer material to appropriate containers for reclamation or disposal.
Absorb remaining material or small spills with inert material and then place in a chemical waste container.

7. HANDLING AND STORAGE

Handling - Avoid contact with eyes, skin and clothing. Avoid breathing vapor or mist and use approved splash goggles and vapor respirator fitted with approved organic cartridge if vaporization or misting occurs. Use with adequate ventilation.

Storage: Store at > 32 °F, away from nit rites , sulfites and alkaline mater ials . Do not store in mild steel, carbon steel or Aluminum . Suitable materials are: glass lining ; PVC; polyp ropylene ; polyethylene and glass reinforced plastics . Keep containers tightly closed when not in use and when in transit.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION EQUIPMENT

Control Parameters:

Active Ingredients		**Source** ACGIH	NIOSH
Sodium Polycarboxylate	Non-Ha za rdous	NE	NE
l-Hydroxyethylidene-1,1-diphosphonic acid	2809-21-4	NE	NE

NE: No Limit Estab lis hed

Exposure Controls:

Eye Protection: Wear safety glass es or chemical splash goggles meeting ANSI Z87.1 or approved equivalent.

Hand & Body Protection: Minimi ze skin contact by wearing protective PVC or Neoprene gloves, overalls or apron is also recommended.

Respiratory Protection: None required under normal handling and transfer cond itions . An approved respiratory protection program meeting OSHA 1910.134 and ANSI Z88.2 requ irements or equivalent must be followed whenever workplace conditions warrant use of a respirator. Where vapors or mist may occur, wear a properly fitted NIOSH-approved or equivalent half-mask, air-purifying respirator fitted with NIOSH-approved organic vapor cartridges.

Engineering Controls: Facilities storing or utilizing this material should be equipped adequate ventilation , eyewash and shower facility.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Clea r Colorl ess to Lig ht Straw Liquid
Upper/Lower Flammabili ty Or Explosive Limits:	Not Determined
Odor:...................................	Mild
Vapor Press ure:	17.5 Mm Hg @ 20°c
Odor Threshold:.........	Not Determined
Vapor Density:........	Not Determ ine d
pH (1 % solution):	< 3.25
Specific Gravity:	1.10 +/- .05
Melti ng Poin t/Freez ing Point:	< 0° C
Solubili ty (in water):	Completely Solu ble
Initial Boiling Point and Boilin g Range:	101°C To 103°C
Flash Point:	Not Determined
Evaporation Rate:	Not Detem1ined
Flammability:.......................	Not Deter mined
Partition Coefficient: N-Octanol/Water:	Not Determined
Auto-Ignition Temperature: ..	Not Determ ined
Decomposition Temperature:	Not Determined
Visc o s ity:	Not Determin ed

Note: The above physical data are typical values . They should not be construed as specification for the product.

10. STABILITY AND REACTIVITY

REACTIVITY May react to strong bases and oxidizing agents
STABILITY: Stable under normal conditions
CONDITIONS TO AVOID: contact with strong bases , strong oxidizers
INCOMPATIBILITY: No further relevant information available
HAZARDOUS DECOMPOSITION: CO, CO2, P2O5, phosphines
HAZARDOUS POLYMERIZATION : Will not occur.

11. TOXICOLOGICAL INFORMATION

This is a blended product. No data on the neat product is avail able. The following data is available for the active components , which have been diluted to make this product.

1-Hydroxyethylidene-1,1-diphosphonic acid:

E e Irritation .... .Irritant (rabbit)	Dermal LD_{50}..........> 7940 mg/kg (rabbit)
Skin Irritation . ... .Irritant (rabbit)	Oral LD_{50} ....> 2350 mg/kg (rat)

Sodium Pol carbox late:

E e Irritation ... .Sli ht Irritant (rabbit)	Dermal LD_{50}..........> 5000 mg/kg (rabbit)
Skin Irritation ....Non-irritant (rabbit)	Oral LD_{50} ....> 5000 mg/kg (rat)

Respiratory : Can cause respiratory tract injury leading to lung , edema
Skin : Causes skin irritation
Eye: Causes serious eye damage
Carcin ogenicity: There are no known carcinogenic chemicals in this product

12. ECOLOGICAL INFORMATION

This is a blended product. No ecological information on the neat product is available. The following data is available for the active components, which have been diluted to make this product.

1-Hydroxyethylidene-1,1-diphosphonic acid:

Algae	(Selenastrum Capricomu tum), 96 Hour EC50:		3.0	mg/l
	NOEC:.		1.3	mg/l
Fish	Bluegill Sunfish (Lepomis macrochirus), 96 Hour LC50	>	800	mg/l
	NOEC :..		529	mg /l
	Rainbow Trout (Salmo gairdneri), 96 Hour LC50:..	>	350	mg /l
	NOEC: .. .. Sheephead Minnow, 96 Hour		151	mg/l
	LC50:.........	>	2100	mg /l
	NOEC:		104	mg/l
	Channel Catfish , 96 Hour, 96 Hour LC50	>	650	mg/l
	NOEC:..		529	mg/l
Invertebrates	Daphnia magna , 48 Hour EC50:	>	500	mg/l
	NOEC:.		400	mg/l
	Grass Shrimp (Palaemonetes Pugio), 96 Hour EC50:..........	>	1700	mg/l
	NOEC:..		104	mg/l

This component has low avian tox icity, is slightly toxic to oysters and is practically non-toxic to fish and invertebrates. Algal growth inhibition is due to ability of the product to complex materials and not to toxicity per se.

Sodium Polycarboxylate

Daphnia magna , 48 Hour EC50:	> 2,750 mg /l
NOEC:	2,200 mg /l
Rainbow trout (Sal mo gairdn eri), 96 Hour LC50:	> 4,850 mg /l
NOEC:	1,300 mg /l
Bluegill sunfish (Lepomis ma croch irus) , 96 Hour LC50:	> 10,000 mg/l
NOEC:	10,000 mg /l

13. DISPOSAL CONSIDERATION

Disposal Method: For small quantities neutralize with lime or soda ash and flush away with plenty of water. For la rge spillage absorb spillag e onto sand or other absorbent material and dispose of as solid waste as per lo cal regulations (e .g. incine ration) . Surplus product can be incine rated.

If the product was supplied in a single use container, care should be taken to dispose of the container in a responsible manner and in accorda nce with applicable regulations. Label precautions should be followed for any residual material in the container. Whenever poss ible , our company encourages recycling of containers.

14. TRANSPORT INFORMATION

U.S. DOT (Department of Transpo rtatio n) Hazard Class: Nonregulated

Other Shippin g Information - DOT Marking - Not applicable
Hazardous Substance /RQ - Not appli ca ble
49 STCC Number - Not applica ble

Keep container tightly closed. Protect again st physica l damage.

15. REGULATORY INFORMATION

Following information pertains to each active component in the produc t, when applicab le.
UNITED STATES
SARA TITLE 3 (Superfund Amendments and Reauthorization Act) - Not liste d
Section 302 Extremely Hazardous S ubstanc es (40 CFR 355) - Not listed
Section 311 Hazard Category (40 CFR 370) - Immediate (Acute) Health Hazard Section
312 Threshold Planning Quantity (40 CFR 370) - 10,000 lbs
Section 313 Reportable Ingredients (40 CFR 372) - Not listed

CERCLA (Comprehensive Environmental Response Compensation and Liability Act) (40 CFR 302.4)-Not list ed . TSCA

(Toxic Substance Control Act) (40 CFR 710) - Listed

16. OTHER INFORMATION

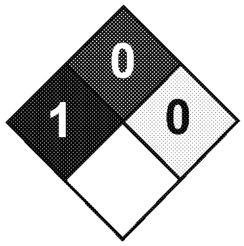
Suggested HMIS Ratings -	Health - 2	Flammabi lity - 0	Reactiv ity - 0	Protection - B
NFPA Rating	Health - 2	Flammability - 0	Reactivity - 0	Specia l - None

HMIS Rating not es - Protection B = Splash Proof Safety Goggles, Gloves

Date Prepared: 5-20-2015

The information contained herein is to the best of our knowledge and belief, accuraet , but any recommendations or suggestions made are without warranty or guarantee of results, expressed or implied. We therefo,reassume no liabilit

ScienceLab.com
Chemicals & Laboratory Equipment



Health	1
Fire	0
Reactivity	0
Personal Protection	E

Material Safety Data Sheet
Potassium chloride MSDS

Section 1: Chemical Product and Company Identification

Product Name: Potassium chloride

Catalog Codes: SLP3334, SLP5143, SLP2317, SLP4126

CAS#: 7447-40-7

RTECS: TS8050000

TSCA: TSCA 8(b) inventory: Potassium chloride

CI#: Not available.

Synonym:

Chemical Name: Potassium Chloride

Chemical Formula: KCl

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Potassium chloride	7447-40-7	100

Toxicological Data on Ingredients: Potassium chloride: ORAL (LD50): Acute: 2500 mg/kg [Guinea pig]. 2600 mg/kg [Rat]. 1500 mg/kg [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects: Slightly hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to blood, cardiovascular system. Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

Skin Contact:
Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used.

Serious Skin Contact: Not available.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: Not applicable.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Slightly explosive in presence of oxidizing materials.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards: May result in explosion with potassium permanganate and sulfuric acid.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

Section 7: Handling and Storage

Precautions:
Do not ingest. Do not breathe dust. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, acids, moisture.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Hygroscopic

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection: Safety glasses. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid.

Odor: Odorless.

Taste: Saline. (Strong.)

Molecular Weight: 74.55 g/mole

Color: White.

pH (1% soln/water): Not available.

Boiling Point: 1420°C (2588°F)

Melting Point: 770°C (1418°F)

Critical Temperature: Not available.

Specific Gravity: 1.987 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility:
Soluble in cold water, hot water. Very slightly soluble in methanol, n-octanol.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, acids.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Hygroscopic. Incompatible with $KMnO_4$, H_2SO_4, BrF_3, and $BrCl_3$. May react violently with BrF_3.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.

Toxicity to Animals: Acute oral toxicity (LD50): 1500 mg/kg [Mouse].

Chronic Effects on Humans: May cause damage to the following organs: blood, cardiovascular system.

Other Toxic Effects on Humans: Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:
May affect genetic material. Passes through the placental barrier in animal.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: May cause skin irritation Eye: Dust may cause eye irritation. Inhalation: Dust may cause respiratory tract irritation. Low hazard for usual industrial handling Ingestion: May affect behavior (coma, change in motor activity, listlessness, vertigo, mental confusion, paresthesias, general weakness, flaccid paralysis), metabolism, blood (change in clotting factor, electrolytic imbalance), cardiovascular (hypotension, circulatory disturbances, cardiac arrhythmias, heart block), and respiratory, gastrointestinal (irritation of GI tract, nausea, vomiting, diarrhea, abdominal discomfort, purging), and urinary(impairment of renal function) systems. Acute potassium intoxication by mouth is rare because large single doses usually induce vomiting, and because in the absence of pre-existing kidney damage potassium is rapidly excreted. Maximal nontoxic oral dose of KCl in man varies from 0.2g to 1 g of potassium/kg/day depending upon efficiency of individual excretory mechanism; lower doses sometimes cause impairment of renal function as shown by reduced inulin, and urea clearance. Chronic Potential Health Effects: May affect blood and cardiovascular system.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Federal and State Regulations: TSCA 8(b) inventory: Potassium chloride

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada): Not controlled under WHMIS (Canada).

DSCL (EEC):
R36- Irritating to eyes. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S39- Wear eye/face protection.

HMIS (U.S.A.):

Health Hazard: 1

Fire Hazard: 0

Reactivity: 0

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 1

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Safety glasses.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

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